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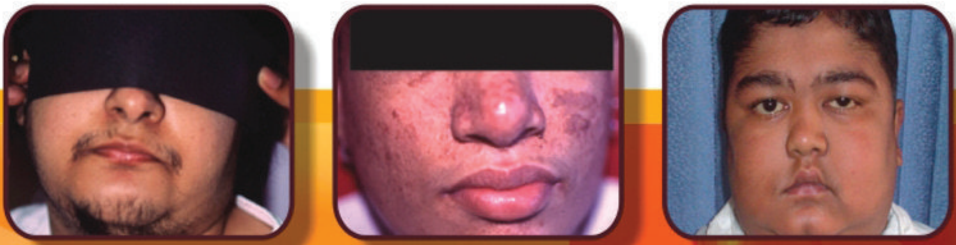
Manual of Clinical & Practical Medicine



Manual of Clinical and Practical Medicine

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Medical knowledge is constantly changing. As new information becomes available, changes in treatment, procedures, equipment and the use of drugs become necessary. The authors, editors, contributors and the publishers have, as far as it is possible, taken care to ensure that the information given in this text is accurate and up-to-date. However, readers are strongly advised to confirm that the information, especially with regard to drug dose/usage, complies with current legislation and standards of practice.

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Dedicated

To our wives

Pushpa, Jayshree and Anjana

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Preface

Today's student is required to read, know and remember a vast amount of information. It is a difficult task for students, especially at the graduate level. In an attempt to satisfy above, clinical and practical medicine tend to get neglected, which then becomes the main stumbling block at the practical examination. The problem is compounded further by the availability of modern diagnostics, which though useful, further erode the process of acquisition of clinical skills.

In day-to-day working in outpatients and wards, students adopt shortcut methods of history taking and clinical examination with the result that they fail to elicit and demonstrate the clinical signs during practical examination. This manual is therefore targeted to this weakness of large majority of students. The intent and scope of the manual is simple, to help the student prepare for the medicine practicals and to help understand what is essential. It is in no way intended to replace textbook of medicine.

Bedside examination is the most important component of practicals. Based on interpretation/conclusions of the clinical examination, one can plan cost-effective and rational investigations to arrive at proper diagnosis and then institute the appropriate therapy.

The skills needed for a competent clinical examination can only be mastered at bedside by clinical practice. One has to particularly sharpen senses of sight (inspection), touch (palpation) and hearing (to appreciate percussion and auscultation). This manual explains and stresses these points with the help of sketch diagrams. The manual offers a quick revision of clinical methods.

The manual sequentially covers clinical methods, clinical cases, investigations, diagnosis and therapy principles in a concise form. Pharmacotherapy is not described in detail (except in Chapter 15, Emergencies). There is a chapter, "Table viva voce," that covers commonly asked questions and their answers. To facilitate understanding and to reinforce key points, diagrams, photographs, boxes and bullets have been used liberally. Chapters on other components of practicals, i.e. Electrocardiology, Imaging (mainly X-rays), Procedures, Diet, Table viva voce and Emergencies follow next. An appendix of normal laboratory values is provided.

We are grateful to our many colleagues who have helped us with photographs (clinical, imaging etc.) for preparation of this manual (see acknowledgments). We extend our sincere thanks to Elsevier India Pvt. Ltd. for their constant encouragement and support, including secretarial help.

Preface

We really do not know how to express our special gratitude to our wives and children for their tolerance and understanding during the preparation of this book.

We will gladly receive suggestions, comments and corrections from our colleagues and students to make the manual more user-friendly and useful.

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Chapter 1

History taking and general examination

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INTRODUCTION

Clinical skills are acquired continuously during the lifetime practice of clinical medicine. Learning bedside clinical medicine requires knowledge and experience. A physician forms an impression about a patient right from the time the patient enters his consultation room. The way the patient walks in and the way he interacts during history taking provide a wealth of information. The physician has to be focused on obtaining maximum possible information to arrive at a proper diagnosis. The consultation room should be cool, comfortable and well lighted. The physician should avoid attending to phone calls and other jobs. The best clinical examination is carried out in an office setting. For inpatients in a common unit, the physician should pull the curtains around the bed, interview the patient and discuss his illness in a soft tone to keep patient's problems confidential from neighboring patients. A physician should be an attentive listener, be friendly and know when to speak and what to say.

Diagnosis should be based mainly on history and clinical examination supplemented by appropriately ordered laboratory and imaging investigations.

STRUCTURE OF HISTORY

1. Demographic data
    a. Name, age and sex
    b. Race/religion
    c. Date and place of birth
    d. Occupation
2. Presenting or chief complaints
3. History of present illness (with details of investigations, treatment received and response)
4. History of past illnesses
5. Family history (blood relatives)
6. Personal and social history
    a. Occupational history (sedentary/desk job or active job requiring travel, physical labor etc.). Ask about present and past occupational history.
    b. Habits (smoking, alcohol, drugs, exercise etc.)
    c. Allergy to drugs
    d. Marital status
    e. Menstrual and obstetric history (in women)
    f. Number of children
    g. Social status
7. Dietetic history
8. Lifestyle

HISTORY TAKING

Presenting complaints

Start by asking "Tell me why have you come to see me?" Avoid asking direct questions; however, occasionally asking a direct but open question encourages the patient to reveal facts in a proper sequence. Allow the patient to tell his complaints, and then ask him about the main complaint that is bothering him the most. List his complaints either in a chronological order or in the order of severity. Presenting complaints give a clue to the system or organ involved. If the patient tells diagnosis, e.g. bronchial asthma, ask him to describe the symptoms. Never accept the diagnosis labelled for his ailment till confirmed. The dictum is that if you carefully listen to the patient's history, he will invariably give a lead to the diagnosis.

The accuracy of history is influenced by the individual patient's subjective response to a symptom, language and intelligence. If patient cannot provide adequate history, narration of history by an accompanying person or an interpreter will be helpful. If the patient is unconscious, one has to rely on the history given by the accompanying persons.

History of present illness

The pattern of questions to be asked regarding each complaint (origin, duration and progress), starting with the chief complaint, should be as follows:

- When did the first symptom start?
- Was the patient completely OK before that?
- Did he suffer from the same symptom before?
- Did it start suddenly or insidiously?
- Did he consult a physician? What did the physician advise, and what was the result? What are the reasons (if any) for the change of physician?
- How has the symptom progressed, is it worse or better, or is there any relationship between any factors and relief with medication?
- How is he feeling now?

Thus, after knowing the details of each complaint, compile the history of present illness in a chronological order. At the end, ask relevant questions and enquire regarding the absence of symptoms pertaining to the suspected disorder. Make sure that the patient's positive and negative symptoms are recorded in the history of present illness.

History of past illness

Ask about previous illnesses, operations, accidents etc. the patient had since childhood and note relevant details.

Keeping in view the patient's complaints and the probable diagnosis, ask relevant past history of the following:

- Childhood illnesses, e.g. measles, rubella, chickenpox, poliomyelitis, whooping cough, mumps and herpes, and immunizations and vaccinations
- Hypertension (HT), diabetes mellitus (DM) and dyslipidemia in ischemic heart disease (IHD) patients

- Rheumatic fever with arthritis in valvular heart disease patients,
- Episodic epigastric pain related to meals in peptic ulcer patients
- Hematemesis, melena, jaundice and drowsy/stupor stage signifying chronic liver disease
- Chronic bronchitis and bronchial asthma in patients with chronic obstructive pulmonary disease (COPD)
- Low-grade fever, cough, loss of appetite and loss of weight suggesting tuberculosis
- History of allergies
- In female patients, age at menarche, menses, pregnancies, miscarriages, toxemia of pregnancy, breast feeding and consumption of oral contraceptive pills, and in postmenopausal women, hormone replacement therapy if any.

Family history

Ask if any family member has had a similar illness. It is important especially in heredofamilial diseases such as Huntington's disease (autosomal dominant) and hemophilia (sex linked). Ask about common environmental factors such as unbalanced diet, smoking (active/passive), poor hygiene and poverty, which are important in infections such as tuberculosis and leprosy.

Family history helps in recognizing diseases of multifactorial etiology that have familial aggregation. One should therefore ask family history of diseases such as obesity, DM, HT, IHD, stroke, dyslipidemia, cancer, bronchial asthma, migraine, mental disorders, thyroid diseases, osteoarthritis, allergies, tuberculosis and alcohol or drug addiction.

Enquire about the age and causes of death of all first-degree relatives to ascertain the history of premature deaths or of longevity.

Personal and social history

Enquire about married life, children, nature of job, hobbies, sports, and habits, such as smoking, alcohol consumption, timings of meals, sleep and exercise. One gets immense information if one asks the patient to describe his activities on a typical working day and on weekends. Ask about his sleep, bowel habits and stress at work place or at home; also, it will be worthwhile knowing about the persons living with him, whether he has any pets, whether he is a member of any club or whether he is connected with any social organization. Ask about foreign travel. Ask about his sexual life, as some of the psychosomatic symptoms may have a basis of sexual inadequacies. Ask about effort tolerance, whether he gets easily tired, whether he can climb two flights of stairs without getting breathless, whether he has difficulty in going to sleep or wakes up early and then cannot sleep and whether he takes sleeping tablets. Weight is a good index of good health, so ask whether the patient is loosing or putting on weight and whether it is steady.

Smoking

If the patient is a smoker, enquire about the form (cigarettes, bidis, cigars, pipe etc.) and the quantity (number of cigarettes, bidis, cigars etc.) used. Ascertain pack years. The staining of teeth and fingers suggests that patient is a heavy smoker. Similarly, if the patient is a tobacco chewer, ask the brand, frequency and quantity. Tobacco-related disorders should be considered in a smoker (Box 1.1, Fig. 1.1).

Alcohol

The physician must find out the type of alcoholic drink (whisky, beer, wine), frequency, quantity and duration of the habit. Roughly one glass of wine, half pint of beer or one peg (60 ml) of spirits is considered 1 unit of alcohol.

The safe drinking limit for men is 24 units/week, and for women, it is 14 units/week. Consumption of alcohol above these limits leads to various disorders (Box 1.2, Fig. 1.2).

Drug history

Ask about all the medications along with their dosages the patient is taking for his present illness, and ask whether he is taking tranquillizers, sleeping

Important tobacco-related diseases **Box 1.1**

- Cardiovascular system (CVS) – HT, IHD, peripheral vascular disease and thromboangiitis obliterans
- Respiratory system – Chronic bronchitis, emphysema and bronchogenic carcinoma
- Gastrointestinal (GI) system – Acute gastritis, peptic ulcer, oral cancer and cancer esophagus
- Genitourinary – Carcinoma bladder
- Central nervous system (CNS) – Stroke, apathy, hallucinations, addictions and amblyopia

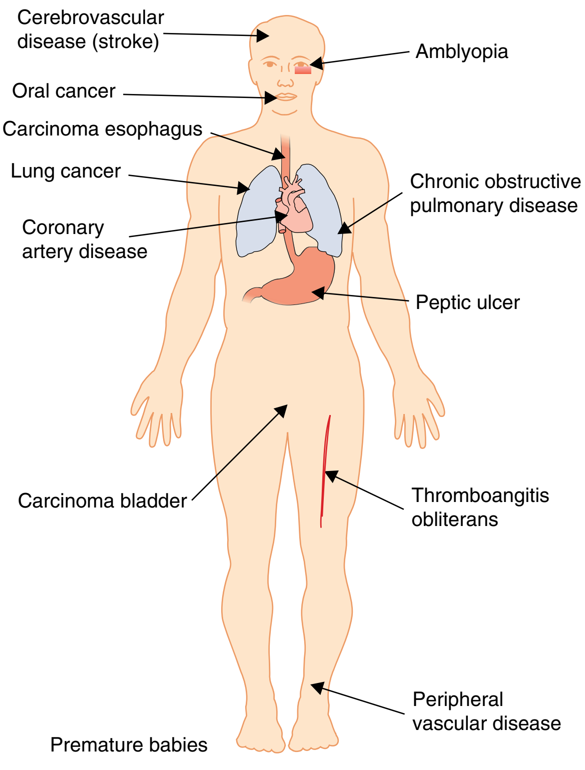

Cerebrovascular disease (stroke)
Amblyopia
Oral cancer
Carcinoma esophagus
Lung cancer
Chronic obstructive pulmonary disease
Coronary artery disease
Peptic ulcer
Carcinoma bladder
Thromboangitis obliterans
Peripheral vascular disease
Premature babies

Figure 1.1 Tobacco-related disorders.

Adverse effects of alcohol abuse

Box 1.2

- Liver – Alcoholic hepatitis and cirrhosis of liver
- GI system – Esophagitis, gastritis, peptic ulcer, pancreatitis and Mallory–Weiss syndrome
- CNS – Withdrawal tremors, delirium tremens, Wernicke's encephalopathy, Korsakoff's syndrome, dementia and peripheral neuropathy
- CVS – HT and cardiomyopathy
- Genitourinary – Impotence and infertility
- Musculoskeletal – Myopathy and avascular necrosis of bone

tablets, pain killers and vitamin supplements on a regular basis.

Ask about illicit drug use, whether oral or intravenous, whether he has been sharing needles with other people (Box 1.3), whether he has developed mental or social problems due to illicit drug use, and whether he is addicted or drug dependence has developed.

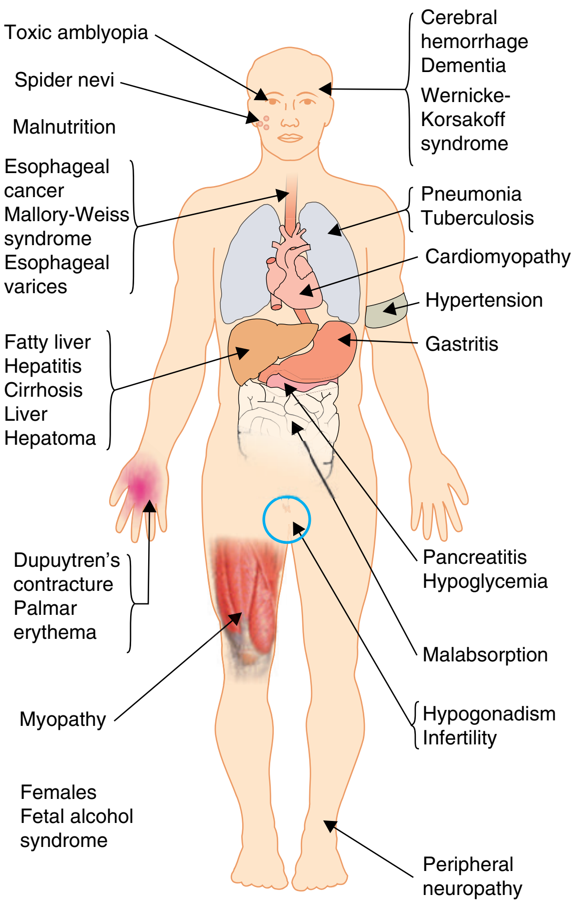

Toxic amblyopia
Spider nevi
Malnutrition
Cerebral hemorrhage
Dementia
Wernicke-Korsakoff syndrome
Esophageal cancer
Mallory-Weiss syndrome
Esophageal varices
Pneumonia
Tuberculosis
Cardiomyopathy
Hypertension
Gastritis
Fatty liver
Hepatitis
Cirrhosis
Liver
Hepatoma
Dupuytren's contracture
Palmar erythema
Pancreatitis
Hypoglycemia
Malabsorption
Myopathy
Hypogonadism
Infertility
Females
Fetal alcohol syndrome
Peripheral neuropathy

Figure 1.2 Adverse effects of alcohol abuse.

Diseases caused by needle sharing

Box 1.3

- Hepatitis B, C and HIV infections
- Thrombophlebitis
- Right-sided infective endocarditis

Dietetic history

It is not enough to know that a patient is a vegetarian or nonvegetarian but it is necessary to find out whether the patient is taking a balanced diet. Ask the patient to give a detailed account of what he eats and drinks from the morning till night, so that one can then approximately estimate the number of calories, protein, fat and carbohydrate proportions consumed by the patient and to assess nutritional disorders, vitamin and iron deficiencies and dyslipidemias (see Chapter 14).

Recent changes in the patient's appetite or dietary patterns and whether he has been advised to avoid certain foods for the prevention of GI-related symptoms should be noted. For example, patients with intestinal lactase deficiency should avoid milk and patients with gluten sensitivity should avoid wheat products. Lack of fiber in diet leads to constipation, and excessive fiber in diet may result in gaseous distension, bulky stools and increased frequency of bowel movements.

Occupational history

Ask about the occupation of the patient, duration and nature of work, whether he is putting extra and irregular hours and whether he is overstressed in his job. Some of the classical industrial diseases such as chronic lead poisoning, asbestosis and silicosis occur as a result of exposure to lead, asbestos and silicon respectively. Continuous working on a computer has become an important cause of musculoskeletal symptoms. Also, enquire whether in his work place, he is exposed to dust, fumes and vapors; whether he uses protective special suit and goggles and whether any of his coworkers have similar complaints. Try to find out whether he is happy with the work, employer and colleagues and whether he has any worries, including financial.

PHYSICAL EXAMINATION

Physical examination commences as the patient walks into the consultation room or while the patient is in bed. Even before starting history taking, decide whether the patient looks well or sick and whether he has any obvious physical abnormality. Quick shuffling gait and pill-rolling tremors of Parkinson's disease or the unsteady broad-based gait of an ataxic patient should strike the physician as the patient enters the room.

At the first acquaintance, a handshake with the patient gives some clues. For example, cold and sweaty hands suggest a nervous and anxious patient in contrast to warm and sweaty handshake indicating hyperthyroidism. The handshake is a diagnostic physical sign in patients with myotonia dystrophica (a rare autosomal dominant inherited disease of the muscles); a typical feature observed in these patients is a slow relaxation of the grip on completion of the handshake. Also, one notices premature frontal balding, cataract and testicular atrophy in these patients.

Both obesity and severe malnutrition can be recognized at a glance. One can observe and assess the patient regarding his mood, posture, decubitus, gait, abnormal movements, speech, skin lesions, obvious swellings including thyroid enlargement, lipomas, clubbing, cyanosis, pallor, distended neck veins, pulsatile arteries in neck, swelling of feet etc.

General examination

What follows is a bird's eye view of general examination. The details of individual abnormalities are described in the respective sections on systemic examination.

Ideally, the patient should be made to lie comfortably on a couch or bed with an adjustable backrest. Use pillows for patients who are breathless in flat position. Clothes should be removed, and the patient should be covered with a sheet. In day-to-day practice, this may not be necessary or possible. Physical examination should ideally be carried out in a private room with good lighting and comfortable temperature. For female patients, one should have a woman as a chaperon.

Decubitus

- Patients with cardiorespiratory diseases, such as bronchial asthma, cor pulmonale and congestive cardiac failure (CCF), prefer to have a propped up position with a backrest or a sitting position sometimes with head resting on a small table or a trolley.
- Patients with pleurisy or pneumonia feel comfortable while lying on diseased side. Hemiplegic patients lie with paralyzed side immobile (arm flexed and the leg extended and externally rotated).
- Patients of meningitis lie in an extended neck position (head burrowed in pillow).
- Patients with acute peritonitis prefer to lie still as against patients with abdominal colic, who are restless with legs drawn towards the abdomen.

Face

A good look at the face of the patient gives clues for the probable diagnosis. Many conditions have typical facial appearance:

- Endocrine disorders – Rounded moon like face (Cushing's syndrome), prominent eyes with staring look (hyperthyroidism), puffy dry face with periorbital nonpitting edema (myxedema; Fig. 1.3), long face and coarse features with elongated protruding jaw (acromegaly)
- Puffy face with pitting periorbital edema, and thin shiny skin (nephrotic syndrome)
- Mask-like face (parkinsonism; Fig. 1.4)
- Toxic and sick look with high fever (toxemia due to infection)
- Pathetic look (depression)
- Small flat face, small nose, upward-slanting eyes and protruded tongue with idiotic facial expression (Down's syndrome; Fig. 1.5)
- Frontal bossing – Rickets and sickle cell anemia

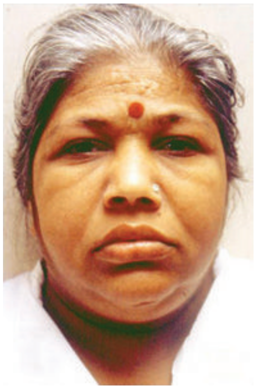


Figure 1.3 Myxedema.

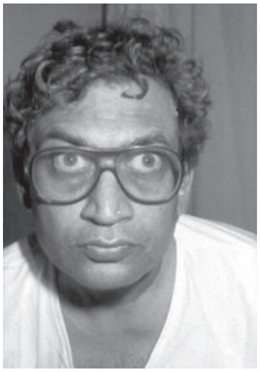


Figure 1.4 Parkinsonian face.

- Periorbital heliotrope rash (dermatomyositis)
- Blue sclera (osteogenesis imperfecta)
- Vesicles (herpes simplex) around lips and nose (febrile illness, e.g. malaria, pneumonia, meningitis)
- Malar pigmentation (chronic malaria)
- Chloasma (blotchy pigmentation of the face) seen in pregnancy and in women taking OC pills
- Malar flush (mitral stenosis)
- Butterfly rash over nose and cheeks (systemic lupus erythematosus [SLE])
- Absence of forehead wrinkles, flattening of nasolabial fold and drooping of the angle of mouth on the side of palsy (VII cranial nerve palsy or Bell's palsy)
- Ptosis along with divergent squint (III cranial nerve palsy)
- Partial ptosis with enophthalmos (Horner's syndrome)
- Spider nevi and telangiectases (cirrhosis of liver)
- Vitiligo (thyroid disorders, autoimmune diseases)
- Hansen's rash (Fig. 1.6)
- Adenoma sebaceum (tuberous sclerosis; Fig. 1.7)
- Shrue mouth (juvenile idiopathic arthritis; Fig. 1.8)

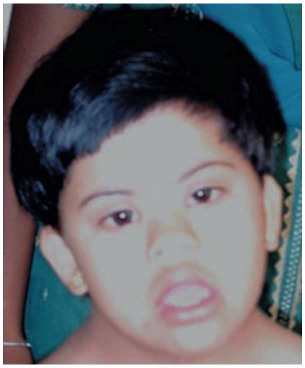


Figure 1.5 Down's syndrome.

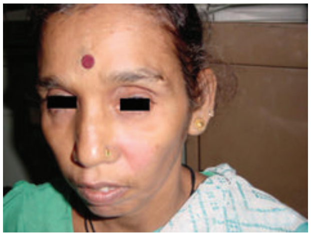


Figure 1.6 Hansen's rash.

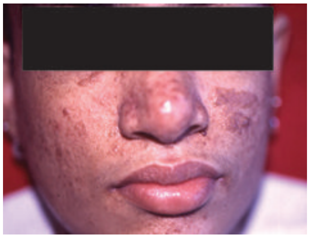


Figure 1.7 Adenoma sebaceum.

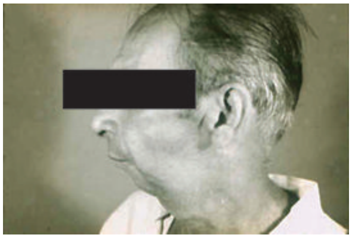


Figure 1.8 Shrue mouth.

Built, development and nutrition

Note whether the patient is thin, lean, obese, stocky built or emaciated and record the height, weight and waist and hip circumferences. Height is normally equal to arm span (fingertip-to-fingertip measurement of outstretched arms and twice the leg length from pubis to heel). Height may be more or less than average (very tall or unduly short) (Box 1.4).

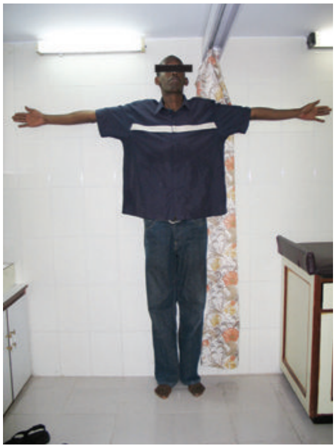


Figure 1.9 Marfan's syndrome; arm span is more than the height and long spidery fingers.

Causes of tall and short stature **Box 1.4**

Tall stature – causes	Short stature (dwarf) – causes
▪ Gigantism	▪ Familial (hereditary)
▪ Marfan's syndrome (Fig. 1.9)	▪ Genetic disorders – achondroplasia, Down's syndrome, Turner's syndrome
▪ Klinefelter's syndrome	▪ Cretinism, hypopituitarism
▪ Kallmann's syndrome	▪ GI disorders – celiac disease, cystic fibrosis, steatorrhea
▪ Laurence–Moon–Biedl syndrome	▪ Renal – chronic renal failure (CRF)
▪ Eunuchoidism (hypogonadism)	▪ Nutritional – protein energy malnutrition, rickets.
	▪ Cardiac – cyanotic congenital heart disease

Causes of emaciation and loss of weight

- Protein-calorie malnutrition in children (kwashiorkor, marasmus; Box 1.5)
- Long-standing, untreated tuberculosis
- Cachexia of malignancy (Fig. 1.10)
- Chronic suppurative lung disease
- Malabsorption syndrome
- Anorexia nervosa

Nutritional status is assessed by measuring skinfold thickness and by the estimation of body mass index (BMI). Skinfold thickness is measured at biceps, triceps, infrascapular and suprailiac

Differences between kwashiorkor and marasmus **Box 1.5**

	Kwashiorkor	Marasmus
▪ Weight loss	Mild	Severe
▪ Growth retardation	Mild	Severe
▪ Edema	Present	None
▪ Wasting	Minimal	Marked
▪ Skin and hair changes	Present	Absent
▪ General appearance	Miserable, irritable	Normal
▪ Serum albumin	Low	Normal

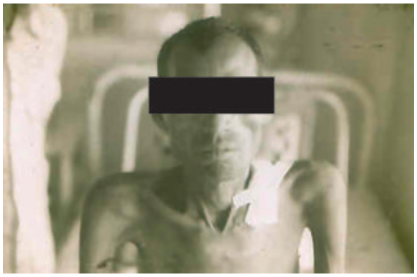


Figure 1.10 Cachexia of malignancy.

regions using a Harpenden or Scofield's calliper. In adult males, the skinfold thickness is 12.5 mm, and in adult females, it is 16.5 mm. BMI gives the assessment of nutritional status, which is calculated as BMI = weight (kg)/height (m)^2 (Fig. 1.11).

Nutritional status	BMI	BMI for Indians
• Underweight	<18	<18.5
• Normal	18–25	18.5–22.9
• Overweight	26–29	23.0–27.9
• Obesity	30–39	28.0–32.9 (Class I) 33.0–37.9 (Class II)
• Gross obesity	≥40	≥38 (Class III)

Waist:hip ratio is measured in an erect position, waist girth at the level equidistant between the costal margin and iliac crest and hip at the level of greater trochanters. A waist:hip ratio of 0.8 or less in women and less than 0.9 in men (pear-shaped figure) is considered healthy, but a greater waist:hip ratio (apple-shaped figure) is unhealthy (visceral obesity) (Fig. 1.12 shows a woman before and after treatment of obesity).

Measurement of waist alone is adequate to decide about visceral obesity. Waist girth of 35 inches or more for women and 40 inches or more for men defines visceral obesity.

Water content of body

In a normal person, 60–65% of the body weight is made up of water, out of which two-thirds is intracellular and one-third is extracellular; of the extracellular water, two-thirds is interstitial and the rest forms the circulating blood volume.

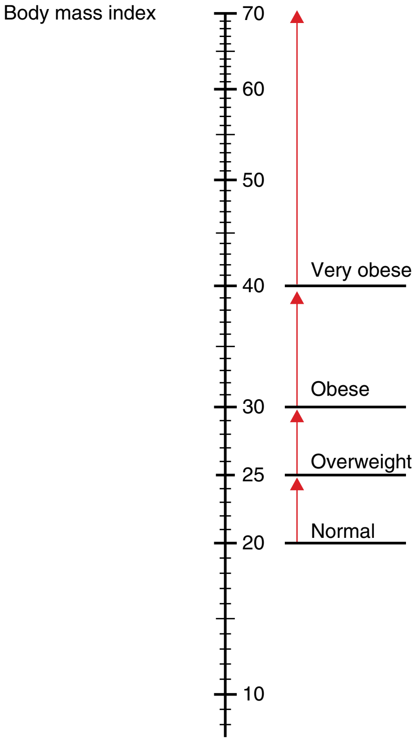


Figure 1.11 Body mass index [weight (kg)/height (m)^2].

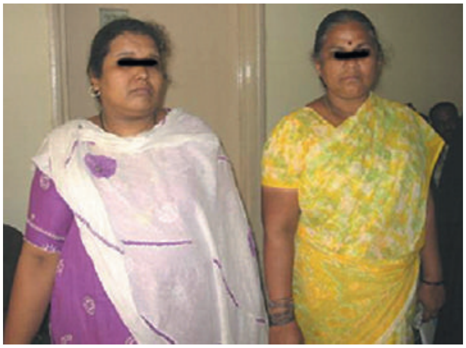


Figure 1.12 Obesity.

Dehydration

Dehydration is assessed by the following:

- Loss of skin elasticity (in old age, skin elasticity is lost due to the diminution of skin collagen)
- Dryness of tongue and mouth (also seen in mouth breathers and smokers)
- Parched lips
- Fall in blood pressure (BP), weak pulse and tachycardia

- Eyeballs sunken and soft due to a decrease in intraocular tension (indrawn face)
- Collapse of jugular veins and fall in jugular venous pressure
- Rise in Hb% and plasma osmolality
- Concentrated, dark-colored urine
- In infants, depressed anterior fontanelle

Pulse

Note the pulse rate, rhythm and volume (see Chapter 3 for more details). Count the pulse for at least 1–2 minutes (normal, 60–80 per minute). Fast pulse (tachycardia) is commonly seen during excitement, exertion, anxiety, fever, hyperthyroidism and shock, while slow pulse (bradycardia) is seen in athletes, myxedema and heart block. For rhythm, check whether it is (sinus) regular or irregular. For volume, ascertain whether it is normal, high (bounding pulse) or low (thready pulse).

Respiration

Note the rate and type of respiration (normal rate, 11–18 per minute).

Breathing pattern abnormalities (Fig. 1.13)

- Tachypnea – Rapid breathing
- Dyspnea – Awareness of breathing and difficulty in breathing
- Orthopnea – Breathlessness on lying down

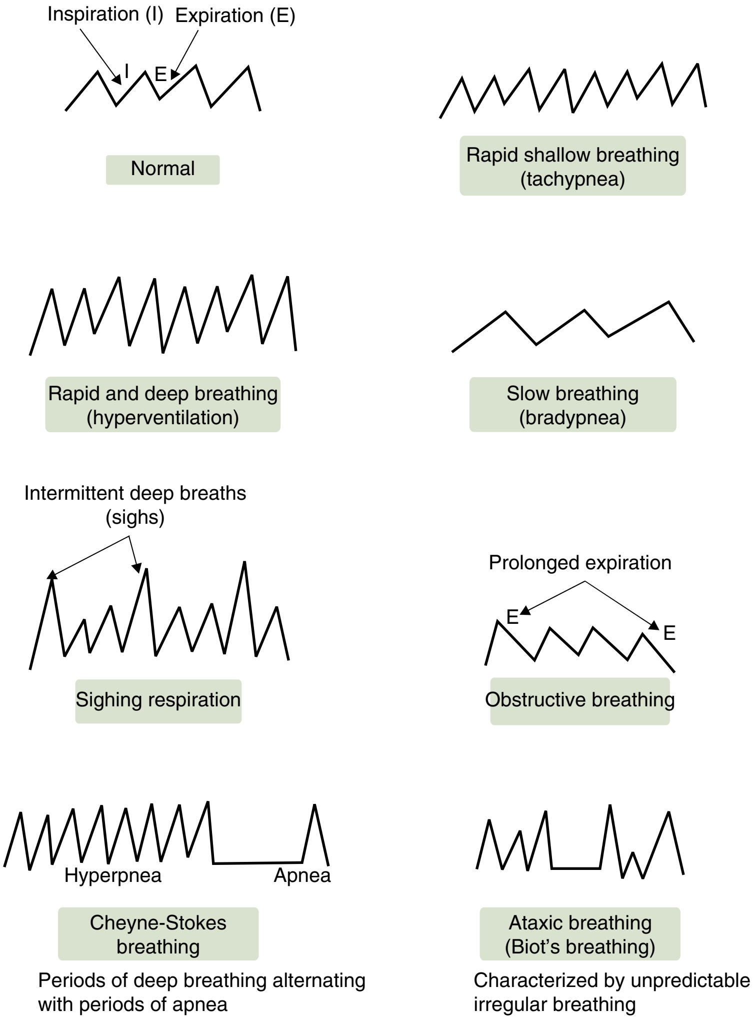

Inspiration (I)
Expiration (E)
I
E
Normal
Rapid shallow breathing (tachypnea)
Rapid and deep breathing (hyperventilation)
Slow breathing (bradypnea)
Intermittent deep breaths (sighs)
Sighing respiration
Prolonged expiration
E
E
Obstructive breathing
Hyperpnea
Apnea
Cheyne-Stokes breathing
Periods of deep breathing alternating with periods of apnea
Ataxic breathing (Biot’s breathing)
Characterized by unpredictable irregular breathing

Figure 1.13 Breathing patterns.

- Cheyne–Stokes – Cyclic fluctuation of respiratory rate and depth
- Biot's respiration – A variant of Cheyne–Stokes respiration (there are abrupt stops and starts and no periodicity, i.e. irregular)
- Kussmaul's respiration – Deep regular respiration
- Hyperventilation – Fast breathing in anxious patient
- Sighing – Shallow nervous breathing with intermittent deep inspiration
- Gasping – Terminal irregular and intermittent breaths
- Stertorous – Noisy due to secretions and upper airways obstruction

Respiration can be thoracic, abdominal or abdomino-thoracic. The common causes of fast breathing (tachypnea) are exertion, fever, anxiety, hypoxia, CCF, pleurisy, pneumothorax, metabolic acidosis and hysteria (for more details, see Chapter 4).

Temperature

Temperature measurement can be axillary, oral or rectal, but oral measurement is preferred. Keep thermometer under the tongue for at least 1 minute. Normal oral temperature is 36.6–37 °C. With diurnal variation of 1 °C, the lowest temperature (36–37 °C) is noted between 2:00 and 4:00 A.M. and the highest in the afternoon. Axillary temperature is 0.5 °C lower, while rectal temperature is 0.5 °C higher than the oral temperature. Temperature can vary from hypothermia to hyperpyrexia (Box 1.6).

Hypothermia

Common causes of hypothermia are

- Myxedema (myxedema coma stage), Addison's disease
- Hypopituitarism (Simmond's cachexia)
- Alcoholic intoxication
- Poisoning with barbiturates, opiates and phenothiazines
- Exposure to severe cold
- Autonomic dysfunction (dysautonomia)

Abnormalities of body temperature **Box 1.6**

	Temperature (°F)	Temperature (°C)
▪ Hypothermia	<95	≤35
▪ Subnormal	95–97	35.0–36.7
▪ Normal	97–98.5	36.7–37
▪ Fever (pyrexia)	99–105	37.2–40.5
▪ Hyperpyrexia	>105	>40.5

Hyperpyrexia

Common causes of hyperpyrexia are

- Malaria
- Heat stroke
- Septicemia
- Pontine hemorrhage
- Encephalitis
- Tetanus

Types of fevers

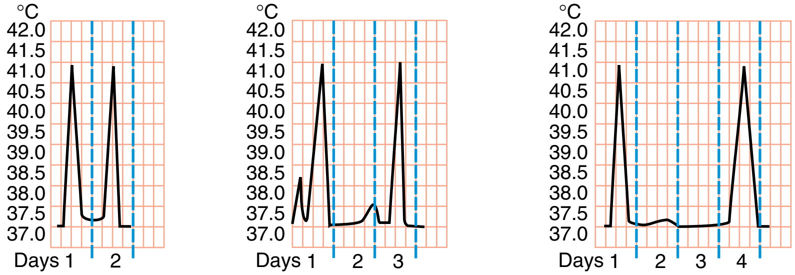
1. **Intermittent** – Temperature touches normal during 24 hours.
2. **Remittent** – Temperature does not touch normal and daily fluctuations exceed 2 °C.
3. **Continuous** – Temperature does not fluctuate more than 1 °C and does not touch normal during 24 hours.

Fever can be intermittent daily (quotidian), on alternate days (tertian) or with a gap of 2 days (quartan). In Pel-Ebstein-type fever, there are alternate febrile and afebrile periods. Fever may take 3 days to reach peak, stay high for 2–3 days and remit over 2–3 days, followed by an afebrile period of 8–9 days (seen in Hodgkin's disease). In case of low-grade fever (37.8 °C) particularly in the evening, rule out tuberculosis or HIV infection or both (Fig. 1.14).

Blood pressure

BP, like pulse, varies from time to time (depending upon a person's emotional and activity status). BP, particularly systolic pressure, rises with emotional outburst, exercise, meals, alcohol, smoking, distension of bladder and pain. Systolic pressure is influenced by stroke volume of heart and stiffness of arterial wall, whereas diastolic pressure is determined by peripheral vascular resistance.

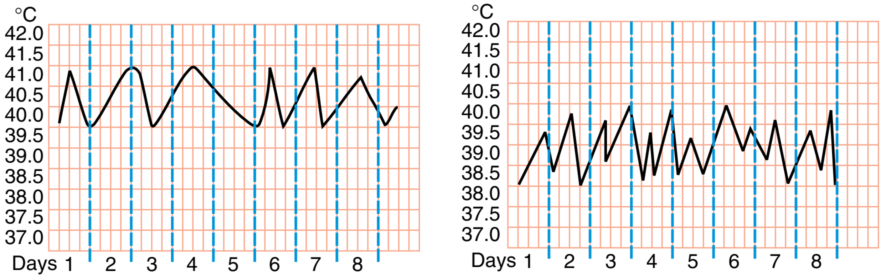
BP should preferably be measured by mercury sphygmomanometer, which is the most accurate. Aneroid meter needs to be periodically calibrated and reset. Electronic BP instruments should preferably be avoided because readings vary and these too need to be calibrated.



Quotidian fever

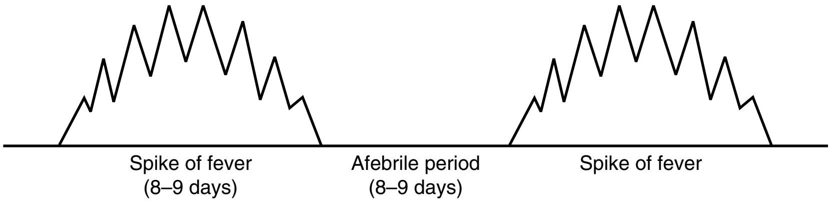
Tertian fever

Quartan fever



Continuous fever

Remittent fever



Pel-Ebstein fever

Figure 1.14 Types of fevers.

While BP is recorded, the patient should be relaxed in lying or sitting position with the arm rested at heart level and clothing removed from the arm. In sitting and standing positions, the arm and sphymomanometer must be horizontal at the level of heart (4th intercostal space at the sternum).

One should use correct-size cuffs. For an average adult, a bladder length of 30–35 cm and cuff width of 12 cm is desirable. The length of the bladder should be at least one and a half times the circumference of the arm. For children, smaller-size cuffs (width, 8 cm), and for obese persons, 15-cm cuffs should be used.

After applying the cuff (bladder should be above the brachial artery), palpate the brachial pulse at antecubital fossa, inflate the cuff until the pulse is impalpable, and then slowly deflate the cuff until the pulse is palpable; the mercury reading at this point equals the systolic BP (SBP) by palpatory method. Deflate the cuff completely and bring the mercury level to zero. Again inflate the cuff higher than the level of SBP (as detected by palpation) and then slowly deflate the cuff while auscultating over the brachial artery until Korotkoff's sounds are heard. The first sounds are clear and tapping (thuds), which gradually increase in intensity. The appearance of thuds (Phase I) gives the SBP by auscultatory method. When the mercury level is slowly lowered, there is softening of the sounds (Phase II), return of sharper and crisper sounds (Phase III), abrupt muffling of sounds (Phase IV) and total disappearance of sounds (Phase V) in succession. Phase I (thud) is taken as SBP, and Phase V (disappearance of sounds) is taken as diastolic BP (DBP). Always take at least two readings. Between the two readings, deflate the cuff completely to zero level and avoid repeated inflation of the cuff, as it causes venous congestion in arm, which gives false higher readings. The cuff should be inflated rapidly with minimum strokes and it should be deflated slowly to get an accurate measurement of BP.

While recording BP, also record the patient's position and the arm used (right or left). If there is a suspicion of postural hypotension, record the BP in lying, sitting and standing positions. Normally, there is very little difference (less than 10 mm) in the three positions if the arm is rested at heart level.

For measuring BP in legs, use larger cuffs with a bladder size of 18 × 24 cm, which should be tied over the thigh with the patient lying in prone position, and palpation and auscultation of the popliteal artery in popliteal fossa are carried out as above. If a proper cuff size appropriate to the thigh is used, BP in legs is almost same as arms, but if an arm cuff is used over thighs, a higher reading of BP is recorded in legs. Similarly, BP may be erroneously recorded high in obese person if the inflatable rubber bag is short for the obese arm.

Note

1. In aortic regurgitation, sounds may not disappear until 0 mm Hg. In such circumstances, Phase IV is taken as DBP.
2. The standard cuff size is 12 cm, which is used for an average adult. For accurate readings, use different sizes of cuffs according to the arm circumference (Table 1.1).

Table 1.1 **Recommended cuff sizes as per age**

Age	Width of the bladder cuff
<1 year	2.5 cm
1–5 years	5 cm
6–10 years	10 cm
Average adult	12 cm
Obese adult	14 cm
Thigh	18 × 24 cm

Cuff size recommendations

Table 1.1 shows different sizes of cuffs to be used.

The length of the bladder should be at least twice that of the width, the average length being 24 cm. The mid portion of the bladder cuff should be placed over the brachial artery.

Auscultatory silent gap

Occasionally, after the initial appearance, Korotkoff's sounds disappear, then reappear again and finally disappear at the diastolic pressure. This silent gap is found in some patients with hypertension. Hence, it is advisable to always use palpatory method before auscultatory method (Fig. 1.15).

It is also advisable to take BP in both arms, and if the difference in the systolic pressure exceeds 10 mm Hg, look for obstructive lesions of the aorta, innominate or subclavian arteries.

Precautions for the measurement of BP

- The patient must be made to rest for a few minutes before recording BP. Alternatively BP should be checked at the beginning and at the end of physical examination.
- The BP may be higher in the right arm by 2–10 mm Hg. We usually take BP in the right arm. But if BP is higher in one arm by 10 mm Hg and more, subsequent readings should always be taken in the same arm.

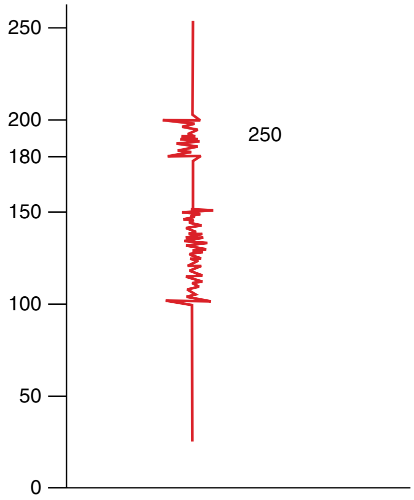


Figure 1.15 Auscultatory silent gap between 180 and 150 mm Hg.

- In supravalvular aortic stenosis and preductal coarctation of aorta, the right arm BP is more than 10 mm Hg higher. In unilateral occlusive disease of the arteries (e.g. atheromatous plaque or thoracic outlet syndrome), BP is low on the affected side.

New trend

In view of individual variation of BP levels with the use of mercury sphygmomanometer, realization has come that BP as measured in clinical practice is very inaccurate. Until recently, we have been strongly recommending use of mercury instrument and not an aneroid or electronic BP instrument. However, recently, a number of automated devices fulfill the criteria of British Hypertension Society. Hence, electronic devices are increasingly being used in multicenter trials, eliminating the problem of inter- and intra-observer errors. These newer electronic instruments are being recommended for clinical practice, but they also require periodic calibration. In our opinion, these electronic instruments are useful in multicenter trials, but in day-to-day practice in India, mercury sphygmomanometers are the instruments of choice.

After checking the patient's BP, examine the patient from head to toes (Boxes 1.7–1.11).

Sinuses and nasal mucosa

Movement of alae nasi suggests acute lower respiratory distress (pneumonia or bronchopneumonia). Test the patency of nasal airways by asking the patient to sniff, as each nostril is occluded in turn by finger pressure. With the help of nasal speculum, examine the nostrils for congestion of nasal mucosa and for polyps. Also check for sinusitis, by applying firm finger pressure over the frontal, nasal and maxillary sinuses to elicit local tenderness.

Skull (Head) **Box 1.7**

- Microcephaly – Mongolism, cretinism
- Macrocephaly – Acromegaly (large bones especially supraorbital ridges, prominent cheek bones and protruding jaw), Paget's disease
- Frontal bossing – Rickets, hydrocephalus, thalassemia major, acromegaly, achondroplasia, congenital syphilis

Hair **Box 1.8**

- Alopecia (loss of hair)
  a. Patchy
    i. Alopecia areata
    ii. Trichotillomania (excessive hair pulling)
    iii. Discoid lupus
  b. Diffuse
    i. Cytotoxic drugs
    ii. SLE
    iii. Severe bacterial infections
    iv. Local scalp infection
    v. Protein deficiency (hypoproteinemia)
- Hirsutism (Fig. 1.16)
  a. Idiopathic
  b. Familial or racial
  c. Polycystic ovarian syndrome (menses may be present)
  d. Congenital adrenal hyperplasia, androgen secreting adrenal or ovarian tumors (menses absent)
  e. Cushing's syndrome
  f. Drug induced, e.g. minoxidil, steroids
- Frontal balding
  a. Male pattern
  b. Myotonia dystrophica
- Flag sign – Kwashiorkor syndrome
- Coarse hair – Myxedema
- Thin hair – Cushing's syndrome, hypoproteinemia
- Loss of outer third of eyebrows – Leprosy, myxedema
- Absent or scanty facial, axillary and pubic hair – Hypopituitarism, hypogonadism, liver cell failure

Look for visible or palpable enlarged and tender temporal arteries (diagnostic of giant cell arteritis). Look for squint, pallor (cheeks, lips, conjunctival lining of lower eyelids), jaundice (superior fornix-sclera, sublingual mucosa, soft palate) and cyanosis (lips, tongue).

Mouth

With the help of a torch and spatula, inspect lips, gums, teeth, tongue, cheeks, floor of the mouth, soft palate, tonsils and oropharynx by asking the patient to say "Ah."

Ear **Box 1.9**

- Large pinna (normal variation)
- Gouty tophi
- Pigmentation – Alkaptonuria
- Cauliflower – Relapsing polychondritis
- Ear lobe crease – Coronary artery disease (CAD) (Fig. 1.17)

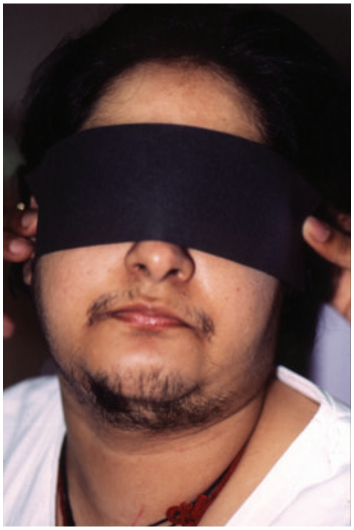


Figure 1.16 Hirsutism.

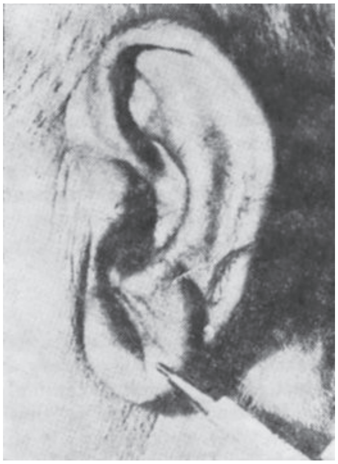


Figure 1.17 Ear lobe crease.

Eye **Box 1.10**

- Proptosis, exophthalmos (thyrotoxicosis; Fig. 1.18)
- Xanthelasma (cholesterol deposits), seen in DM, familial hypercholesterolemia, nephrotic syndrome, chronic obstructive jaundice myxedema
- Squint, Argyll Robertson pupil, ptosis (Fig. 1.19)
- Dry eyes (Sjögren's syndrome), conjunctivitis (Fig. 1.20), vitamin A deficiency – Bitot's spots
- Iritis- ulcerative colitis, rheumatoid arthritis and sarcoidosis
- Blue sclera (osteogenesis imperfecta)
- Cataract, ectopic lens (Marfan's syndrome)
- Pallor, jaundice, cyanosis and fat embolism (Fig. 1.21)
- Arcus senilis in elderly persons
- Ochronosis
- Kayser–Fleischer ring, a golden brown deposition of copper seen at the periphery of cornea (Wilson's disease)
- Amyloid deposits over eyes (Fig. 1.22)

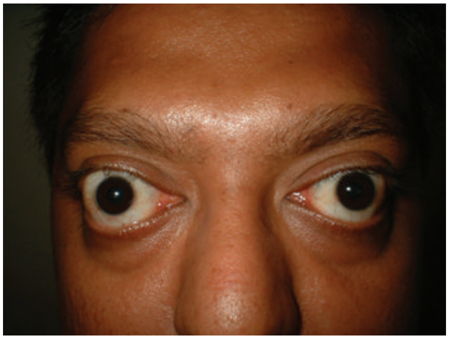


Figure 1.18 Exophthalmos – A thyroid eye disease.

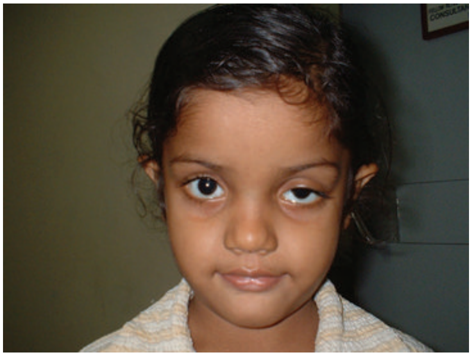


Figure 1.19 Ptosis.

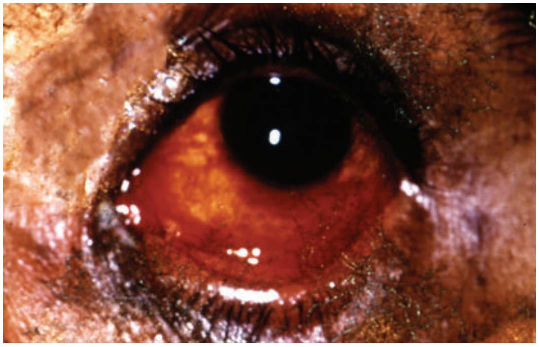


Figure 1.20 Conjunctivitis.

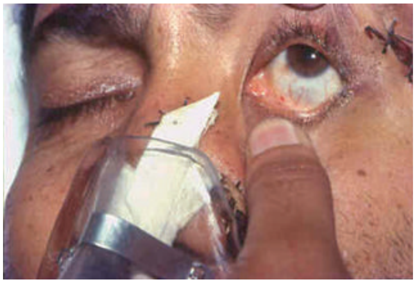


Figure 1.21 Fat embolism.

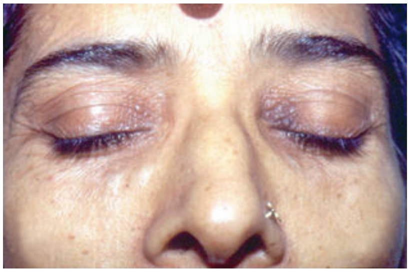


Figure 1.22 Amyloid deposits.

Nose

Box 1.11

- Depressed bridge due to bone destruction – tertiary syphilis
- Depressed mid part due to cartilage destruction – lepromatous leprosy, lupus vulgaris, relapsing polychondritis and Wegener's granulomatosis
- Beaking of nose with tight skin of nose, cheeks, perioral region – scleroderma
- Deformity of nose – trauma

Lips

The lips are dry and cracked in patients with fever and renal failure; angular stomatitis and magenta tongue are seen in deficiency of vitamin B complex, particularly riboflavin; thick and patulous lips are seen in myxedema and acromegaly.

Tongue

Examine whether the tongue is moist or dry (dehydration, mouth breathing, anticholinergic drugs, Sjögren's syndrome). Central cyanosis is best appreciated by inspection of tongue. Look for macroglossia (Box 1.12).

Oral mucosa

Look for aphthous ulcers on the inner side of lips, over buccal mucosa, palate and tongue margins. Some patients suffer from recurrent attacks of aphthous stomatitis. Its cause is usually not known but is usually observed in persons with GI disorders such as inflammatory bowel disease and in persons with anxiety (see Box 2.3).

Pigmentation over the exposed parts can be normal in some people. Pathological causes of pigmentation are Addison's disease (Fig. 1.24), chronic cachexia,

Causes of macroglossia

Box 1.12

- Myxedema
- Mucopolysaccharidosis
- Cretin
- Lymphangioma of tongue
- Acromegaly
- Hemangioma of tongue
- Down's syndrome
- Amyloidosis (Fig. 1.23).
- Glycogen storage disease

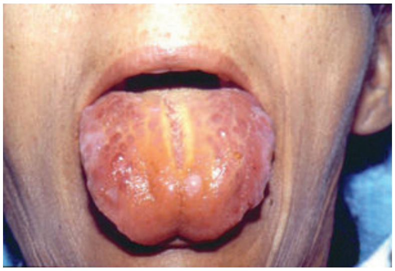


Figure 1.23 Amyloidosis – Macroglossia.

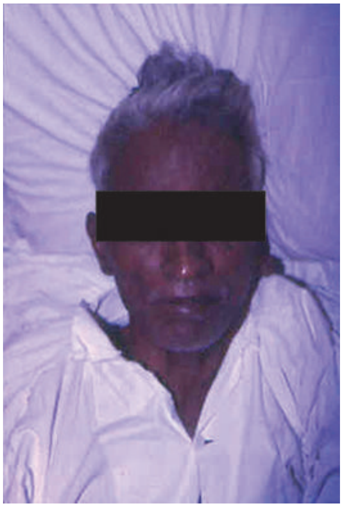


Figure 1.24 Addison's disease.

malabsorption syndrome, hemochromatosis and the rare Peutz–Jegher's syndrome in which in addition to pigmentation, there is polyposis of the small intestine. In Addison's disease, pigmentation is also present over palmar creases and bony prominences (knuckles, olecranon process).

Teeth

Look for caries, discoloration of teeth and missing teeth. In congenital syphilis, upper incisors are notched, separated and peg shaped (Hutchinson's teeth).

Gums

- Gingivitis is characterized by bleeding and narrow line of inflammation at the gum borders. In advanced cases, there is pus collection between teeth and gum margin (pyorrhea alveolaris).
- Halitosis is fairly common because of poor oral hygiene.
- Soft spongy, friable bleeding gums are seen in scurvy (Box. 1.13).
- Spongy and bluish gums are seen in cyanotic congenital heart disease.
- Blue lining is seen in chronic lead poisoning.

Gums — Box 1.13

Hypertrophic

- Scurvy (soft spongy, friable bleeding gums)
- Drugs such as nifedipine and dilantin sodium (Fig. 1.25)
- Acute monocytic leukemias
- Poor oral hygiene
- Idiopathic

Bleeding

- Scurvy
- Gingivitis
- Thrombocytopenia (idiopathic) thrombocytopenic purpura, aplastic anemia, acute leukemia
- Anticoagulant therapy
- Vincent's angina

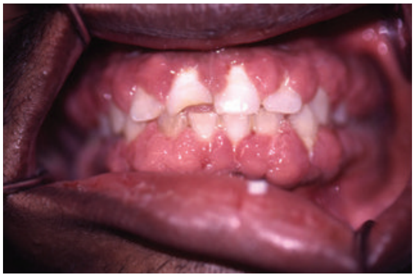


Figure 1.25 Gum hypertrophy.

Palate

- Cleft palate may be associated with cleft lip.
- High-arched palate is found in Marfan's syndrome.
- In XI cranial nerve palsy, movement of soft palate of the affected side is poor or absent with uvula pulled to the normal side.
- Pallor and jaundice is sometimes better seen over soft palate.
- In herpangina due to Group A coxsackie viruses, there are oropharyngeal mucosal vesicular and ulcerative lesions on tonsillar pillars, soft palate, tonsils, uvula and tongue.
- Kaposi's sarcoma appears over palate as red to purple painless macules, which later become painful papules.

Tonsils

- Enlarged tonsils (recurrent infection, malignancy)
- With tonsillectomy, the tonsillar fossae are empty
- Diphtheritic membrane is initially white and glossy but turns into dirty gray and fibrinous. It is adherent and bleeds on removal.

Neck

Lymph glands

Lymph nodes in the neck are better palpated from behind with the patient's neck in flexed position. Palpate for submandibular lymph nodes (enlarged in tonsillar and throat infections), upper deep cervical, lower deep cervical, suboccipital, posterior triangle and supraclavicular lymph nodes (Fig. 1.26). Note whether they are discrete or matted, firm or hard, tender or painless on palpation. Palpate submandibular salivary glands to see if enlarged and tender; check the opening of their ducts in the mouth. Tuberculous lymph nodes are usually firm and matted, whereas in AIDS, Hodgkin's disease or other reticulosis, lymphatic leukemia, and syphilis, the glands are firm or rubbery and discrete.

Neck rigidity should be looked for in patients suspected to have meningitis, meningism or subarachnoid hemorrhage.

Thyroid gland examination

Note the movement of thyroid gland with the larynx during swallowing. Palpate the gland from front and behind, and ascertain if there is a diffuse bilateral enlargement or a single-lobe or nodular enlargement. Determine its consistency (soft, firm or hard), tenderness and palpable thrill (confirmed as audible bruit) found in hyperthyroidism. Finally, check for the pressure on trachea and whether the swelling is extending down into the retrosternal space.

Neck pulsations

Neck pulsations are to be seen and felt. Arterial pulsations (carotids) are both seen and felt, whereas venous pulsations (jugular) are seen but not felt. Carotid pulsations are prominent in aortic incompetence, patent ductus arteriosus and HT. In aortic stenosis, a palpable systolic thrill is felt over carotids. Engorged and pulsatile jugular veins are seen in CCF, whereas engorged and nonpulsatile jugular veins are seen in superior mediastinal compression syndrome and massive pericardial effusion or constrictive pericarditis (Fig. 1.27) (see Chapter 3 for details).

Axillae

Examine both axillae for any glandular enlargement (Fig. 1.26). Note the characteristics.

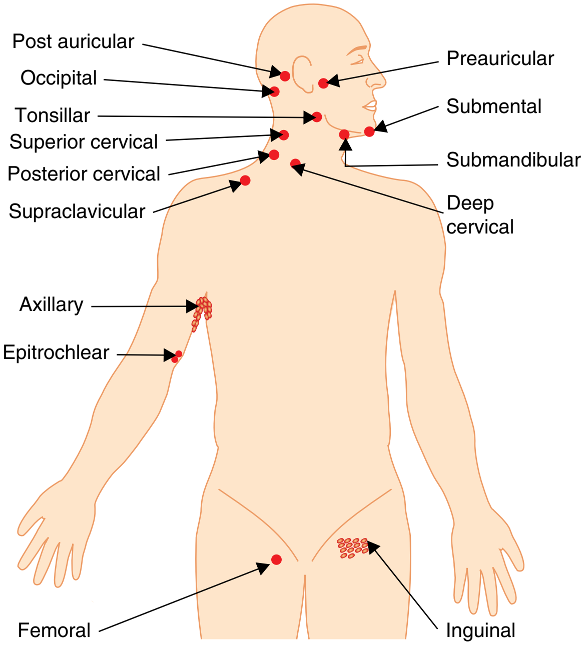


Figure 1.26 Lymph glands to be palpated in general examination.

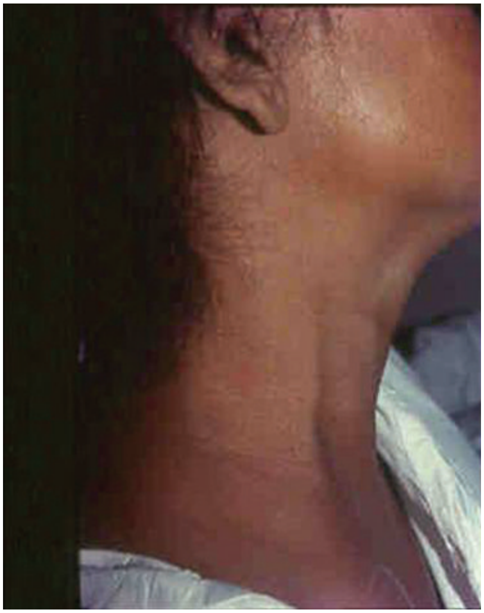


Figure 1.27 Prominent external jugular vein.

Breasts

Examine breasts in females with the patient in reclining position. Note ulceration, dimpling or retraction of nipples; squeeze the nipples for discharge. Breast palpation is better done with the flat part of fingers. If a swelling is felt, note its characteristics.

In males, look for gynecomastia (unilateral or bilateral), felt as fleshy mass (has a granular texture) of breast tissue and not as pectoral fat under the areola. Gynecomastia is seen during puberty and old age (Box 1.14).

Hands

The handshake may give a clue to hyperthyroid state (warm and moist), anxious state (cold and moist), hypothyroidism (dry and coarse skin), acromegaly (large clubbed hands with sweating), warm and blue hands (central cyanosis) and cold and blue hands (peripheral cyanosis).

Note deformities (arthritis, peripheral neuropathy, Volkmann's ischemic contracture), swelling of joints (rheumatoid arthritis, osteoarthritis, gout), the color and shape of nails, presence of nicotine stain, nail bed infarcts, palmar vasculitis (SLE) (Fig. 1.28) and cholesterol deposits in hands (Fig. 1.29).

Causes of gynecomastia **Box 1.14**

- Puberty, old age
- Increased estrogen levels and/or decreased testosterone levels as seen in (1) liver cirrhosis, (2) tumors secreting human chorionic gonadotrophin, (3) Leydig cell tumor of testis producing estrogen and (4) 1° and 2° hypogonadism
- Drugs such as amiodarone, digitalis, estrogen therapy in males, spironolactone and cimetidine
- Lepromatous leprosy
- Bronchogenic carcinoma
- Inherited androgen receptor defect
- Testicular feminization syndrome
- Klinefelter's syndrome
- Kennedy syndrome (X-linked spinal muscular dystrophy)

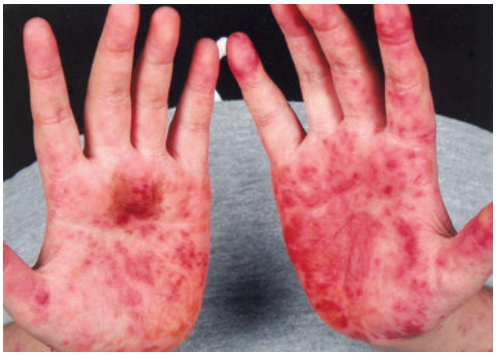


Figure 1.28 Palmar vasculitis (SLE).

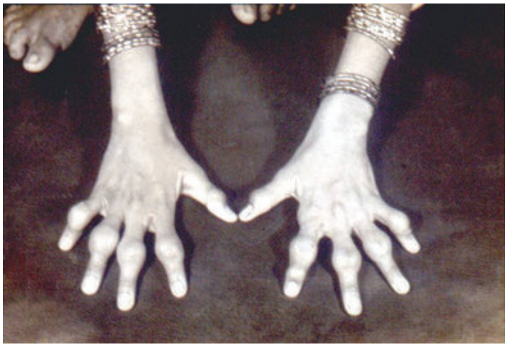


Figure 1.29 Cholesterol deposits in hands.

Tremors of hands (familial, senile, anxiety, thyrotoxicosis, alcoholism, parkinsonism, hepatic and renal failure and carbon dioxide retention) should be noticed.

Other abnormal movements such as chorea, athetosis, choreoathetosis and tetany may be present (see Chapter 5).

Heberden's nodes and Bouchard's nodes (seen in patients with osteoarthritis) are formed on the dorsum of distal and proximal interphalangeal joints, respectively. In rheumatoid arthritis, there is a spindle-shaped swelling of interphalangeal joints and ulnar deviation of all fingers. Look for rheumatoid nodules. In SLE, polyarteritis nodosa, systemic sclerosis, rheumatoid arthritis, nail bed infarcts are noticed (see Chapter 9). In infective endocarditis, Osler's nodes (exquisitely tender nodules in the pulp of fingers), Janeway lesion (nontender palmar nodules) and splinter hemorrhages in the nails are seen (see Chapter 3). Splinter hemorrhages may also result from trauma, collagen vascular disease and trichinosis. Look at palmar creases (pigmented in Addison's

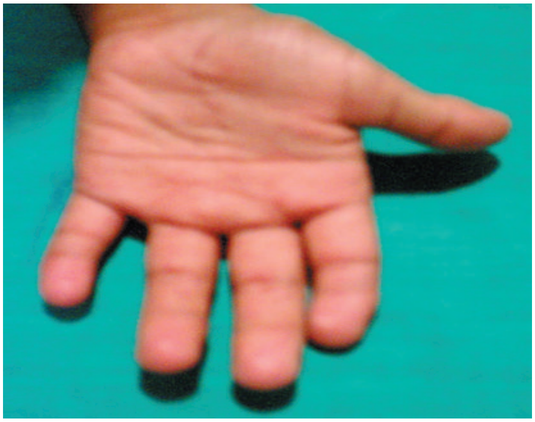


Figure 1.30 Down's syndrome.

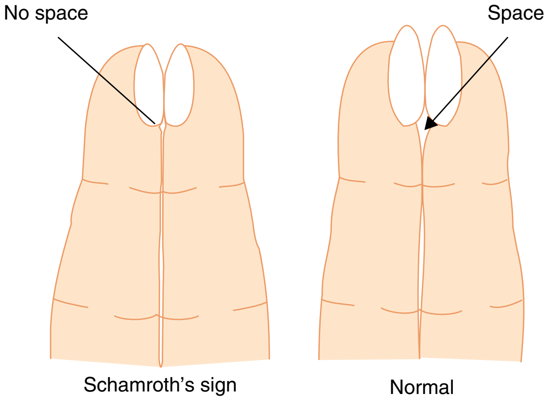


Figure 1.32 Clubbing – Schamroth's sign.

disease, pale in anemia, single crease [Simian] in Down's syndrome; Fig. 1.30). Palmar erythema is a feature of chronic liver disease, rheumatoid arthritis, thyrotoxicosis, pregnancy and CO_2 retention and rarely in normal persons.

In myxedema, hands are broad and the fingers are short and stubby because of thickening of subcutaneous tissues, whereas in acromegaly, hands are massive, broad and paw like. Slender and female-like hands are seen in hypogonadism. In Marfan's syndrome, long spidery fingers (arachnodactyly; Fig. 1.9) and webbing of fingers are seen. Dupuytren's contracture (deformity of hands resulting from fibrous thickening of palmar tissues with flexion of fingers) is usually inherited but may be seen in alcoholism, diabetes and epilepsy. Gangrene of finger tips occurs in vasculitis, progressive systemic sclerosis and antiphospholipid syndrome.

Clubbing probably results from hypervascularity and the opening of anastomotic channels in the nail bed. Grades of clubbing are as follows (Fig. 1.31):

Grade I – There is a bogginess or softening at the base of nail where one can elicit fluctuation.

Grade II – Nail is elevated due to an increase in the soft tissue under the nail bed; the angle of nail plate is lost and may exceed 180°. This is detected by Schamroth's window test. Normally, when both the finger nails are placed opposite each other, there is a diamond-shaped gap, which gets reduced or lost when clubbing is present (Fig. 1.32).

Grade III – Subcutaneous tissue over the base of nail is increased, the overlying skin is shiny and tight, and the increased curvature of nail gives a drumstick- or parrot-beak-like appearance to the finger tip.

Grade IV – This is an advanced grade (gross clubbing) often accompanied with hypertrophic pulmonary osteoarthropathy (there is a thickening of the periosteum of the radius, ulna, tibia and fibula). Patient complains of pain and swelling of wrists and ankles, and subperiosteal new bone formation can be seen on X-rays (see Box 1.15 for causes of clubbing).

Nails

Nails should be examined for clubbing, platonychia and koilonychia (Fig. 1.33). In malabsorption syndrome and after severe illnesses, pitting, ribbing and brittleness of finger nails are seen. Nervous persons with the habit of nail biting have short and irregular nails. In psoriasis, the nails are pitted and deformed. Whiteness at the base of nails (leukonychia) or white spots indicate hypoalbuminemia as seen in chronic liver disease.

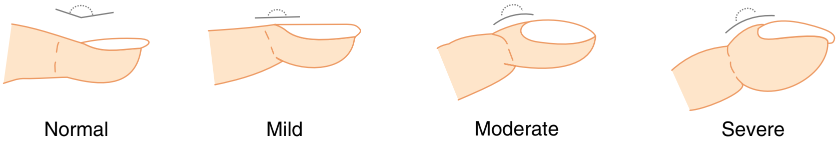


Figure 1.31 Grades of clubbing.

Causes of clubbing

Box 1.15

Pulmonary

- Bronchiectasis
- Chronic lung abscess
- Bronchogenic carcinoma
- Interstitial pulmonary fibrosis
- Chronic empyema
- Mesothelioma
- Pulmonary arteriovenous fistula
- Extensive fibrocaseous tuberculosis (rare)

Cardiac

- Cyanotic congenital heart diseases
- Infective endocarditis
- Eisenmenger's syndrome
- Atrial myxoma

Gastrointestinal

- Biliary cirrhosis
- Ulcerative colitis
- Crohn's disease
- Malabsorption syndrome (tropical sprue, celiac disease)
- Polyposis coli

Miscellaneous

- Idiopathic
- Heredofamilial
- Thyrotoxicosis
- Congenital

Unilateral clubbing

- Pancoast's tumor
- Subclavian and innominate artery aneurysm
- Arteriovenous fistula of brachial vessels
- Presubclavian coarctation of aorta
- Clubbing of one to two fingers (traumatic)

Clubbing of toes only

- Patent ductus arteriosus (PDA) with reversal of shunt

Occasionally, in CRF, "half and half" nails (white proximally and red brown distally) are seen. Severe illness temporarily arrests the growth of nails, and when growth restarts, transverse ridges develop, which are called Beau's lines. Nail fold telangiectasis is seen in SLE, progressive systemic sclerosis and dermatomyositis. In paronychia, there is an inflammation and swelling of nail folds. Nail abnormalities are listed in Box 1.16.

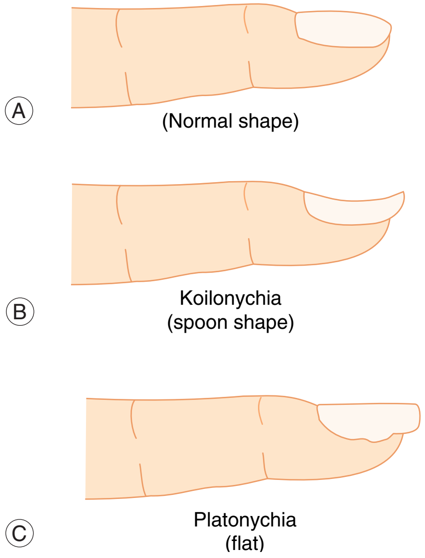


Figure 1.33 Abnormalities of nail; (B) and (C) occur in iron deficiency.

Cyanosis

Cyanosis is bluish discoloration of the skin, nails or mucosa and is due to an increased amount of reduced hemoglobin (greater than 5 g% in capillary blood). Cyanosis may be central or peripheral (Table 1.2).

Peripheral cyanosis is due to diminished capillary blood flow allowing more time for the removal of oxygen by the tissues. There are two mechanisms of peripheral cyanosis:

1. Due to reduced cardiac output (e.g. mitral stenosis, shock)
2. Due to local vasoconstriction (e.g. severe cold) or peripheral vascular disease

Acrocyanosis is persistent, symmetric cyanosis of hands and feet due to vasospasm involving small skin vessels. It is usually caused by exposure to cold. There is no pain.

In central cyanosis, there is less than 85% O_2 saturation; which is seen in the following situations:

1. Deficient oxygenation of blood in lungs resulting from improper ventilation of perfused areas of lung (e.g. lobar pneumonia) or from impaired oxygen transfer across the

Nails

Box 1.16

- Pallor – Anemia and cirrhosis of liver
- Koilonychia (spoon-shaped nails) – Iron deficiency anemia
- Platonychia (flat nails) – Iron deficiency anemia
- Onychia – Fungal or tuberculous infection causes deformity of nail termed as onychia
- Splinter hemorrhages seen under nail beds – Infective endocarditis and bleeding disorders
- Trophic changes – Brittleness and ribbing may be seen in leprosy, tabes dorsalis and syringomyelia
- Beau's lines – Following severe Illness
- Mee's line – Acute arsenic poisoning and fluorosis
- Bitten nails – Anxious (nervous) patient
- Pseudoclubbing due to the resorption of terminal phalanges giving a false clubbed appearance – seen in leprosy, hyperparathyroidism, scleroderma, acromegaly and vinyl chloride exposure
- Onycholysis (nail detached distally from its plate) – Fungal infection, psoriasis, eczema, trauma and thyrotoxicosis
- Half and half nail – Renal failure
- Discoloration – Drugs such as antimalarials, cyclophosphamide and bleomycin
- Nail patella syndrome – (1) Dystrophic nails (Fig. 1.34), (2) rudimentary or absent patellae, (3) iliac horns, (4) subluxation of radial head at elbow and (5) chronic glomerulonephritis

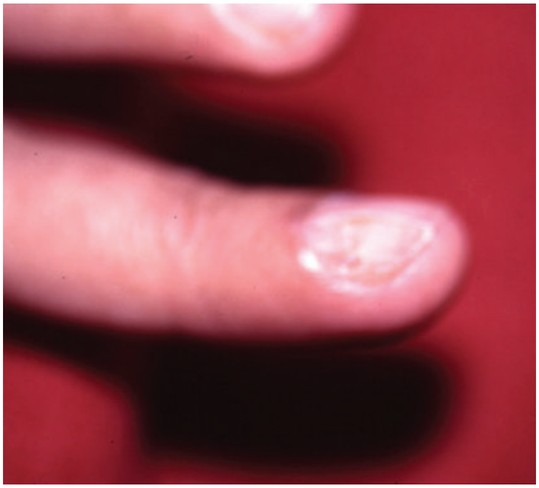


Figure 1.34 Dystrophic nails.

Table 1.2 **The differentiating features of peripheral and central cyanosis**

	Peripheral cyanosis	Central cyanosis
■ Mechanism	Reduced blood flow to local part	Reduced arterial O_2 saturation
■ Local skin temperature (of surface)	Cold	Warm
■ Sites	Over skin only	Skin and mucus membranes (lips, tongue) (Fig. 1.35)
■ Effect of local warmth	Cyanosis decreases	Cyanosis persists
■ Polycythemia	No association	Usually associated
■ Clubbing	No association	Usually associated
■ Effect of pure O_2 administration	No change	Cyanosis decreased
■ Dyspnea	Usually not present	Usually present

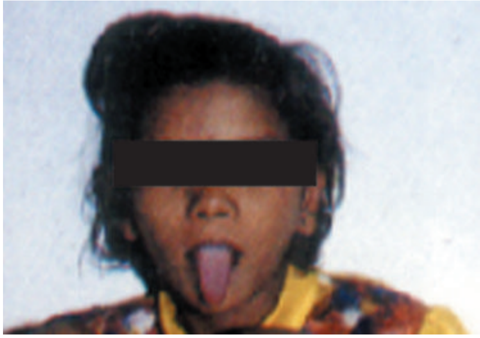


Figure 1.35 Central cyanosis in lips and tongue.

alveolar capillary membrane (e.g. fibrosing alveolitis)

2. Right-to-left shunt at heart level, e.g. Fallot's tetralogy or between a pulmonary artery and vein (arteriovenous fistula)
3. An absolute excess of desaturated hemoglobin, the percentage saturation being normal, seen in primary polycythemia

For causes of peripheral and central cyanosis, see Boxes 1.17 and 1.18, respectively.

Causes of peripheral cyanosis — Box 1.17

- Exposure to severe cold, frostbite
- Peripheral circulatory failure, shock
- Peripheral vascular disease (Buerger's disease, atherosclerosis)
- Raynaud's phenomenon
- Mitral stenosis (lips, cheeks, tip of nose)
- Hyperviscosity syndrome (multiple myeloma, polycythemia, macroglobulinemia)
- Cryoglobulinemia

Causes of central cyanosis — Box 1.18

Cardiac

- Congenital cyanotic heart disease (Fallot's tetralogy, Eisenmenger's syndrome, single ventricle) (right-to-left shunt)

Pulmonary

- Status asthmaticus
- COPD
- Adult respiratory distress syndrome
- Pneumonia
- Interstitial lung disease
- Hypoventilation
- Acute pulmonary embolism
- Tension pneumothorax
- Massive lung collapse
- Arteriovenous fistula (pulmonary)
- Laryngeal edema
- Lack of oxygen (high altitude)

In severe anemia (Hb less than 5 g%), cyanosis is not present because at least 5 g% of reduced hemoglobin is necessary for cyanosis to occur; hence, even if entire hemoglobin is reduced in capillaries, it will be less than 5 g.

Cyanosis due to abnormal pigment (enterogenous cyanosis)

It is caused by the presence of either sulfhemoglobin (greater than 0.5 g/dl) or methemoglobin (greater than 1.5 g/dl). There is no associated breathlessness. The patient may suffer from headache, constipation and lethargy. Abnormal hemoglobins can be detected by spectroscopic examination of the blood. Methemoglobinemia is a rare hemoglobinopathy. Acquired methemoglobinemia is due to accidental exposure to aniline dyes. In both sulfhemoglobinemia and methemoglobinemia, oxygen does not improve cyanosis. Drugs that cause enterogenous cyanosis are as follows:

- Nitrates and nitrites (nitroglycerin, amyl nitrite, sodium nitroprusside)
- Sulfonamides
- Phenacetin
- Dapsone

In carbon monoxide poisoning, there is no cyanosis because carboxyhemoglobin prevents the reduction of oxyhemoglobin, and the former has cherry red color.

Differential cyanosis

- In PDA with the reversal of shunt and in transposition of great vessels, cyanosis is present only in upper limbs.
- In PDA with the reversal of shunt and preductal coarctation of aorta, cyanosis is observed in left upper limb and both lower limbs.

Edema

It is due to the collection of fluid in the interstitial spaces. When 4.5 litres of fluid gets collected, edema becomes evident and it pits on pressure. Edema occurs either due to increase in capillary pressure (e.g. CCF) and/or decreased osmotic pressure (e.g. hypoalbuminemia) or due to increased capillary permeability (e.g. acute inflammation). Obstructed lymphatic drainage results in nonpitting edema (e.g. filariasis).

Venous edema occurs in dependent parts (e.g. legs in ambulant patients and sacrum in recumbent patients). Lymphatic edema is not gravity dependent and may occur in upper limbs, lower limbs or scrotum depending upon the site of lymphatic obstruction.

Causes of pitting edema

Bilateral

- Cardiac – CCF, pericarditis with effusion and constrictive pericarditis
- Hepatic – Liver cirrhosis
- Renal – Nephrotic syndrome and acute glomerulonephritis

- Inferior vena cava obstruction, bilateral varicose veins and bilateral deep venous thrombosis (DVT)
- Nutritional – Hypoproteinemia, anemia, and beriberi
- Allergic – Angioneurotic edema
- Myxedema – Nonpitting edema
- Epidemic dropsy
- Induced by drugs such as steroids, nonsteroidal anti-inflammatory drugs (NSAIDs), nifedipine and amlodipine
- Pregnancy and premenstrual edema
- Idiopathic

Unilateral

- Lymphatic – Filariasis, pressure by growth and radiation
- Infection – Cellulitis and boils
- Venous – Venous thrombosis, varicose veins and removal of vein for coronary artery bypass graft (CABG)
- Traumatic – Fractures and sprains
- Gout
- Milroy's disease (a type of lymphedema)

Anasarca is generalized edema (occurring all over the body).

For causes of nonpitting edema, see Box 1.19

Groins

Examine inguinal regions for palpable lymph nodes (Fig. 1.26). Note their characteristics. Check cough impulse for inguinal hernia.

Palpate femoral artery pulsations.

Legs and feet

Look for the leg and feet abnormalities listed in Box 1.20.

Causes of nonpitting edema **Box 1.19**

- Myxedema
- Elephantiasis (filariasis)
- Chronic venous edema
- Milroy's disease
- Scleredema
- Early stages of scleroderma

Note: Peu-de-orange appearance is seen in lymphatic edema.

Legs and feet **Box 1.20**

- Edema legs or feet – Unilateral/bilateral; pitting/nonpitting
- Bowed legs – Rickets, Paget's disease, osteoarthritis knees
- DVT – Pain, swelling, tenderness of calf or thigh muscles and positive Homans' sign (pain in calf muscles on dorsiflexion of foot)
- Varicose veins are best seen when patient stands. In long-standing patients with varicose veins, pigmentation and varicose ulcers over ankle and leg (medial aspect) are seen
- Arterial pulsations (dorsalis pedis, posterior tibial) – Absent or poor in Buerger's disease, Takayasu's arteritis, atherosclerosis, and DM
- Clubbing of toe nails and other changes in nails as seen in hands
- Deformities
    - a. Pes cavus (high arch with hollowness of soles) seen in Friedreich's ataxia, spina bifida, poliomyelitis, Charcot–Marie–Tooth disease, Refsum's disease
    - b. Talipes equinovarus (congenital anomaly) seen in infants
- Plantar flexion of foot in hemiplegia
- Foot drop in peripheral neuropathy
- Trophic ulcers (diabetic neuropathy), Leprosy (Fig. 1.36)
- Gangrene of toes – Peripheral vascular disease, vasculitis
- Erythema nodosum, Henoch–Schönlein's purpura (HSP) leg rash (Fig. 1.37)
- Toes – Dactylitis and deformities
- Keratoderma blennorrhagica
- Fungal infection of nails

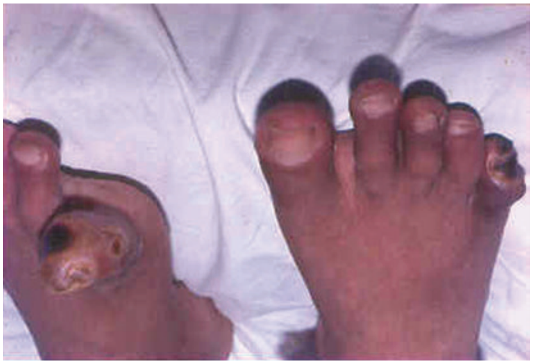


Figure 1.36 Trophic ulcer.

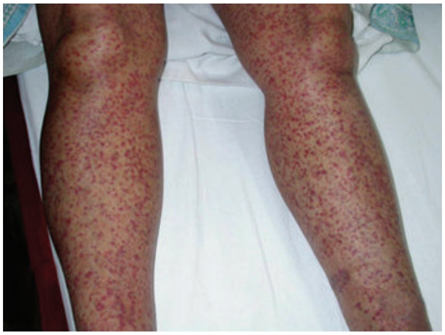


Figure 1.37 HSP leg rash.

Causes of leg ulcers **Box 1.21**

- Venous – Varicose veins, DVT and incompetent valves
- Arterial – Peripheral vascular disease, Buerger's disease and vasculitis
- Neurogenic – Leprosy and DM
- Hematologic – Sickle cell anemia and thalassemia
- Immune-based – Cryoglobulinemia
- Chronic eczema
- Traumatic
- Tumors – Kaposi's sarcoma and melanoma

For causes of leg ulcers, see Box 1.21.

Deformity of the knee joint is commonly seen in patients with osteoarthritis; swelling and tenderness of small joints of feet suggest rheumatoid arthritis; swelling, redness and tenderness of metatarsophalangeal joint of big toe is diagnostic of gouty arthritis.

Inspection of skin

Examination of skin gives important clues.

- Color – Pale (anemia), yellowish (jaundice, carotenemia) and bluish (cyanosis)
- Pigmentation (Box 1.22)
- Hypopigmentation – Vitiligo, albinism, leukoderma, leprosy, fungal infections (tinea versicolor particularly), postburns
- Scaly skin (Box 1.23)
- Scratch marks due to pruritus (Box 1.24)

Causes of pigmentation **Box 1.22**

- Endocrine – Addison's disease
- Infections – Kala-azar, chronic malaria, secondary syphilis and leprosy
- Metabolic – Hemochromatosis
- Malnutrition – Kwashiorkor and pellagra (Fig. 1.38)
- Skin disorders – Acanthosis nigricans, neurofibromatosis and lichen planus
- Toxins – Silver poisoning and chronic arsenic poisoning
- Miscellaneous – Sun tan, exposure to radiation, pernicious anemia, malignancy, lentigines (Peutz–Jeghers syndrome) and melanoma
- Drugs – Antimalarials, cancer chemotherapy and tetracyclines

Causes of scaly skin **Box 1.23**

- Ichthyosis
- Hypoproteinemia (crazy pavement dermatosis)
- Psoriasis (Fig. 1.39)
- Pityriasis
- Seborrheic dermatitis
- Lichen planus
- Ringworm
- Eczema
- Exfoliative dermatitis

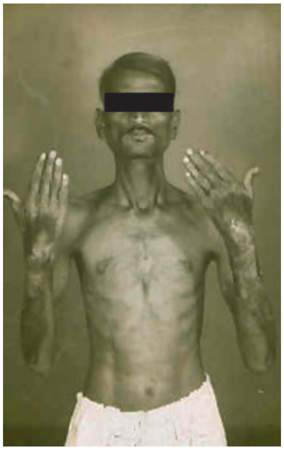


Figure 1.38 Pellagra.

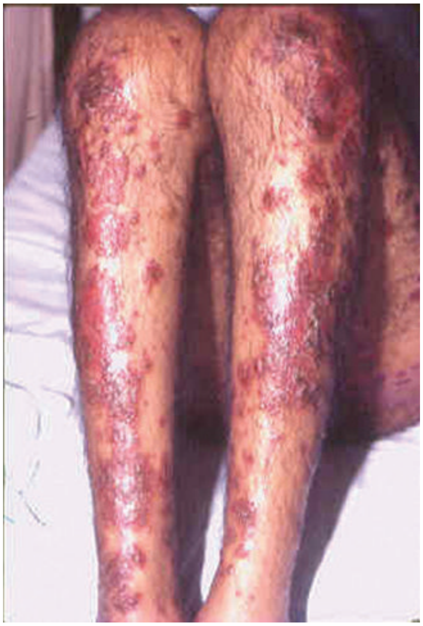


Figure 1.39 Psoriatic skin lesions.

Causes of scratch marks **Box 1.24**

Skin conditions

- Scabies
- Psoriasis
- Drug eruption
- Urticaria
- Ring worm
- Seborrheic dermatitis
- Insect bite
- Dry skin
- Atopic dermatitis
- Lichen planus
- Eczema

Medical conditions

- Obstructive jaundice
- Drug reactions
- Hypothyroidism
- Systemic mastocytosis
- CRF
- Carcinoid syndrome
- DM
- Polycythemia
- Psychogenic – Neurosis
- Pregnancy

- Hemorrhage under the skin can be due to the following:
  - **a.** Petechiae – Tiny hemorrhagic spots less than 1 mm
  - **b.** Purpuric spots – 2–5 mm in diameter
  - **c.** Ecchymosis – Hemorrhage more than 5 mm in diameter
  - **d.** Perifollicular hemorrhage – Vitamin C deficiency (Fig. 1.40)
  - **e.** Hemorrhage in soft tissue – Bleeding under the skin causing elevation of skin with discoloration (Fig. 1.41)
- Scars – Surgical scars and cigarette paper scars (Ehlers–Danlos syndrome; Fig. 1.42)
- Toxic epidermolysis – Stevens–Johnson syndrome (Fig. 1.43)

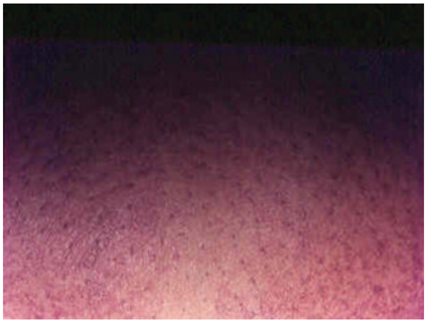


Figure 1.40 Perifollicular hemorrhage.

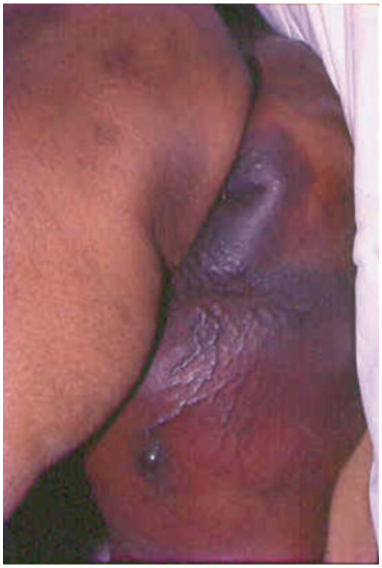


Figure 1.41 Hemorrhage in soft tissue.

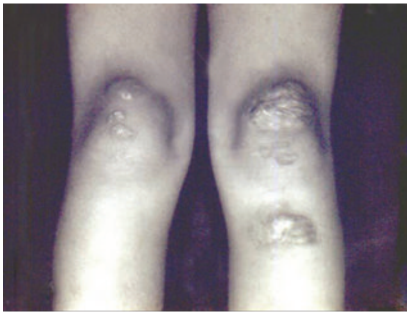


Figure 1.42 Ehlers–Danlos syndrome.

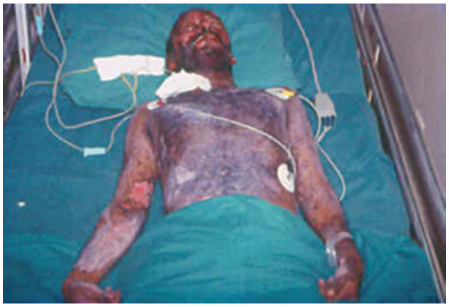


Figure 1.43 Stevens–Johnson syndrome.

Palpation of the skin

Abnormal findings can be as follows:

- Dry skin – Hypothyroidism, dehydration and old age
- Moist skin – Profuse sweating, e.g. shock following acute myocardial infarction, and thyrotoxicosis
- Thick skin – Myxedema
- Thick and tight skin over fingers and face – Scleroderma
- Loose and pinched skin – Dehydration and wasting diseases

Nerves

Palpate the greater auricular, ulnar and lateral popliteal nerves and note if thickened, nodular or tender. The causes of thickened nerves are shown in Box 1.25.

Spine

First, palpate the spine from cervical to sacral region for any deformity or tenderness. Then, check the movements by asking the patient to bend forward, backward and sideways and to rotate. Check the cervical spine similarly. Note limitations in movement and pain. Common deformities are kyphosis, scoliosis, kyphoscoliosis and lordosis.

Causes of thickened nerves

Box 1.25

- Leprosy (Fig. 1.44)
- Diabetes mellitus
- Amyloidosis
- Neurofibromatosis
- Sarcoidosis
- Refsum's disease
- Dejerine–Sottas's disease
- Roussy–Levy syndrome
- Idiopathic hypertrophic neuropathy

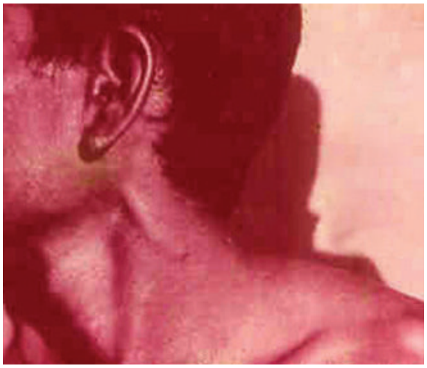


Figure 1.44 Thickened greater auricular nerve in leprosy.

Kyphosis

It is an excessive (abnormal) dorsal prominence of thoracic spine (Fig. 1.45). Its common causes are as follows:

- Posture – Tall persons and coolies carrying weight on the back
- Osteoporosis in elderly persons
- Diseases of spine – Pott's spine, rickets, osteoarthritis, fracture of spine, osteitis deformans (Paget's disease) and Scheuermann's disease
- Neurological diseases – Poliomyelitis, cerebral palsy, Friedreich's ataxia, muscular dystrophies and syringomyelia
- Congenital disorders – Wedge-shaped vertebra
- Ankylosing spondylitis

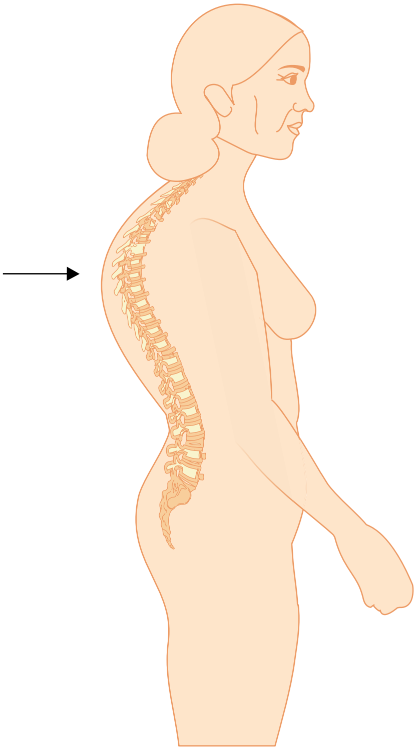


Figure 1.45 Thoracic kyphosis.

Scoliosis

It is an abnormal lateral curvature of the spine. Its common causes are as follows:

- Posture – Carrying heavy weight in one arm
- Rickets, osteomalacia
- Compensatory – Limb shortening
- Neurological diseases – Poliomyelitis, cerebral palsy, muscular dystrophy, poliomyelitis, syringomyelia and hereditary ataxia
- Congenital or developmental disorders
- Osteoarthritis (disc degeneration)
- Ankylosing spondylitis
- Scoliosis, secondary to unilateral lung diseases such as fibrosis, collapse, pneumonectomy or removal of several ribs

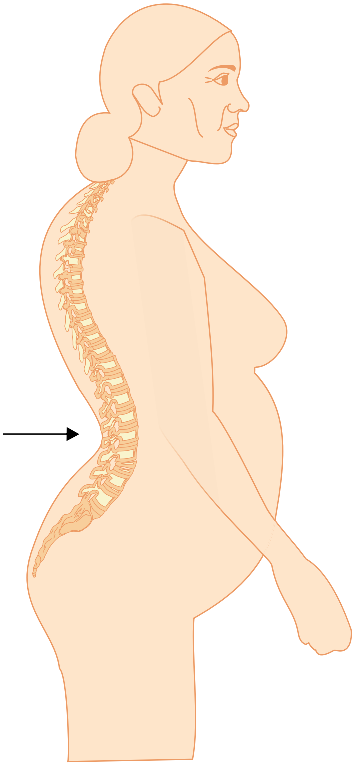


Figure 1.46 Lumbar lordosis.

Kyphoscoliosis

A combination of kyphosis and scoliosis is called kyphoscoliosis.

Lordosis

It is abnormal anteroposterior curvature of lumbar spine with forward convexity (Fig. 1.46). The causes are as follows:

- Pregnancy
- Congenital dislocation of hip
- Muscular dystrophy and other causes of proximal muscle weakness
- Massive ascites
- Large intra-abdominal tumor

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Chapter 2

Gastrointestinal system

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- A case of amebic liver abscess 50
- A case of noncirrhotic portal fibrosis 51
- A case of hepatocellular carcinoma 51
- A case of tuberculosis of abdomen 52

INTRODUCTION

The gastrointestinal (GI) system is a system of serially connected organs and measures 8 m in length, extending from the mouth to the anus. There are secretory glands all along the GI tract. The functions of GI system are propulsion, processing, absorption and elimination of ingested food. Other functions relate to hormonal secretion and immune response.

SYMPTOMS OF GI DISORDERS

1. **Oral** – Dry mouth, water brash, aphthous ulcers, altered taste sensation (dysgeusia) and halitosis.
2. **Esophagus** – Dysphagia, heartburn (retrosternal, epigastric), acid reflux, painful swallowing (odynophagia), feeling of lump in the throat (globus) and hematemesis (see Fig. 2.1 for causes and Figs. 2.2 and 2.3 for endoscopy pictures of esophagitis and duodenal ulcer).

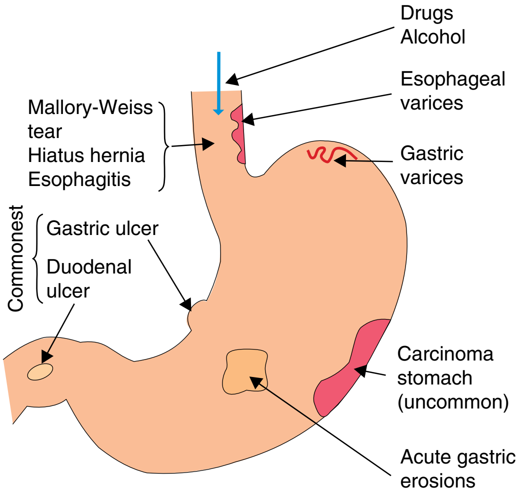
Drugs
Alcohol
Esophageal varices
Mallory-Weiss tear
Hiatus hernia
Esophagitis
Gastric varices
Commonest
Gastric ulcer
Duodenal ulcer
Carcinoma stomach (uncommon)
Acute gastric erosions

Figure 2.1 Causes of upper GI bleeding.

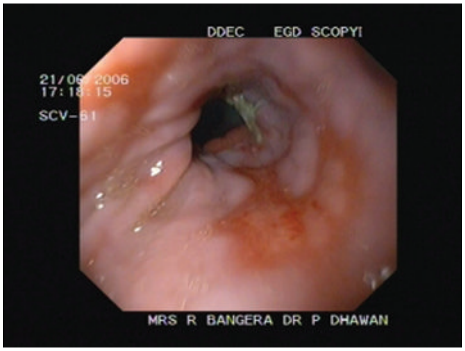
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Figure 2.2 Esophagitis (on endoscopy).

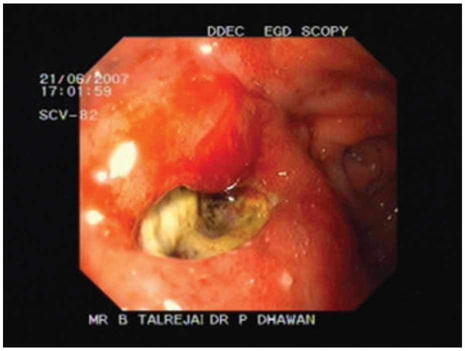
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Figure 2.3 Duodenal ulcer (on endoscopy).

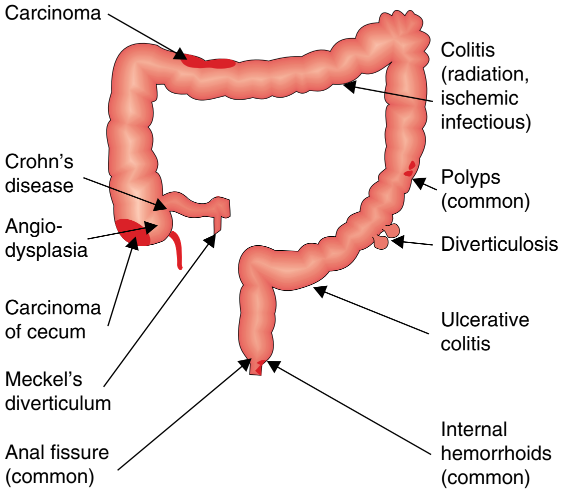
Carcinoma
Colitis (radiation, ischemic infectious)
Crohn's disease
Polyps (common)
Angio-dysplasia
Diverticulosis
Carcinoma of cecum
Ulcerative colitis
Meckel's diverticulum
Internal hemorrhoids (common)
Anal fissure (common)

Figure 2.4 Common causes of lower GI bleeding.

3. **Stomach** – Nausea, vomiting, flatulence (gaseous distension, indigestion, belching), hiccups, epigastric pain and hematemesis.
4. **Intestines** – Constipation, diarrhea, altered bowel habits (carcinoma of colon), alternate constipation and diarrhea (ileocecal tuberculosis, irritable bowel syndrome [IBS]), abdominal distension, lump in abdomen, melena (black stools), hematochezia (bleeding per rectum) (see Fig. 2.4 for causes) and mucus in stools.
5. **General symptoms** – Loss of weight and malnutrition (anemia, edema, vitamin deficiencies).

SYMPTOMS OF HEPATOBILIARY DISORDERS

- Jaundice
- Upper abdominal pain
- Abdominal distension (ascites)
- Edema legs
- Loss of appetite
- Loss of weight
- Bleeding – petechiae, ecchymosis
- Hematemesis, melena
- Fever
- Fatigue, weakness
- Itching (pruritus)
- Altered mental state
- Gynecomastia
- Loss of secondary sex characters
- Decreased libido

We shall now discuss common symptoms:

1. **Causes of dry mouth (xerostomia)** – Dehydration (poor fluid intake, increased fluid loss),

mouth breathing, diseases of salivary glands (mumps, Sjögren's syndrome, salivary calculi), drugs (anticholinergics, antidepressants), depression and anxiety (transient dryness of mouth).

2. **Causes of excessive salivation** – Irritating oral lesions, parkinsonism, esophageal obstruction, anxiety and drugs (iodine containing medicines).
3. **Disorders of taste** – Loss of primary taste sensation (sweet, bitter, salty, sour) due to lesions of VII and IX cranial nerves. Inability to appreciate flavors: disease of nasal mucosa and rarely lesions of olfactory nerves and abnormal taste: cerebral pathology and aura of epilepsy.
4. **Dyspepsia** – Dyspepsia is a symptom complex of nausea, vomiting, vague upper abdominal pain, flatulence, acidity and belching. Common cause is acid peptic disease (ulcerative). Some patients have non ulcer dyspepsia.
5. **Causes of nausea and vomiting** –
   - Acid peptic disease
   - Gastritis secondary to alcohol consumption, drugs and food poisoning
   - Early morning sickness (early pregnancy), infective disorders (viral hepatitis, appendicitis, pancreatitis, acute cholecystitis, malaria)
   - Increased intracranial pressure, migraine, psychogenic, achalasia cardia, pyloric stenosis, radiation therapy, chemotherapy, postoperative and a side-effect of many drugs.
6. **Hyperacidity** – Patient complains of retrosternal and epigastric burning pain, which is worse after meals, particularly after intake of spicy food and consumption of tea, coffee, soft and alcoholic drinks; smoking; and chewing pan masala and tobacco. It may be psychogenic (anxiety, stress, tension).
7. **Dysphagia** (esophageal obstruction, causes are listed in Box 2.1).

   Hiatus hernia is of two types: sliding, in which lower esophagus and upper portion of stomach herniate above the diaphragm, and paraesophageal, in which lower most esophagus and esophagogastric junction remain below the diaphragm but upper portion of stomach herniates into thorax along the side of esophagus (Fig. 2.5). Sliding hernia is common and long-standing cases have typical symptoms of gastroesophageal reflux disease (GERD) (Fig. 2.6).

   Paraesophageal hiatus hernia is uncommon, and cases have no symptoms of GERD but long-standing hernia may get strangulated or may present with bleeding. Barium swallow is useful in identifying the type, size and the complications of hiatus hernias (Fig. 2.7).
8. **Pain in abdomen** (see Fig. 2.8 for causes).
   a. **Colicky** – Caused by spasm or obstruction to a hollow viscera. (a) Intestinal (periumbilical), (b) biliary (right hypochondriac region) and (c) ureteric (lumbar region). Patient is restless, tossing about with legs drawn towards abdomen and hands over the region of pain.
   b. **Inflammation** – Peritonitis (secondary to perforated viscus [intestine, appendix]), cholecystitis and pancreatitis. Pain is constant, the patient lies still. There is tenderness and guarding of abdominal wall, which hardly moves with breathing. Other causes of inflammatory pains are pyelonephritis, cystitis, diverticulitis,

Causes of dysphagia **Box 2.1**

- Upper one-third
  - Severe pharyngitis, esophagitis, esophageal ulcers
  - Carcinoma (pharynx and esophagus)
  - Compression (enlarged lymph nodes and goiter)
  - Neurogenic (bulbar palsy, myasthenia gravis and motor neuron disease)
  - Psychogenic (globus hystericus)
  - Iron deficiency (Plummer–Vinson or Kelly-Patterson syndrome), esophageal web, esophageal diverticulum
- Middle one-third
  - Carcinoma
  - Compression (enlarged lymph nodes, tumors and aneurysm of aorta)
- Lower one-third
  - Carcinoma (stomach, esophagus)
  - Hiatus hernia
  - Esophageal stricture
  - Achalasia cardia
  - Systemic sclerosis
  - Esophagitis
  - Candidiasis

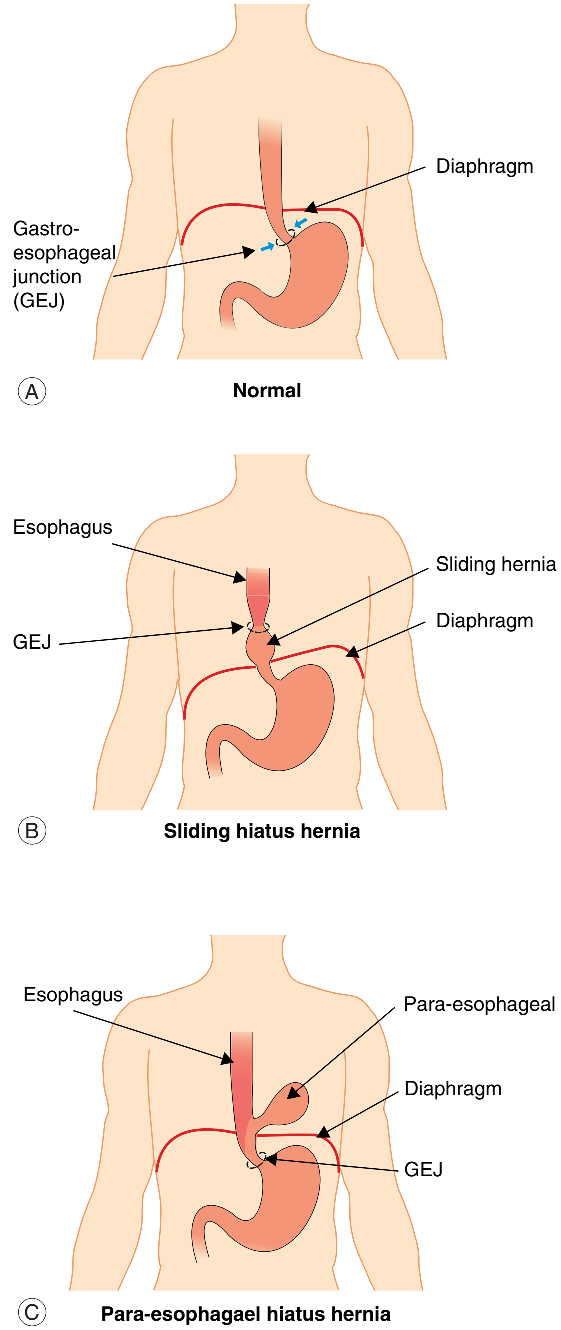
Diaphragm
Gastro-
esophageal
junction
(GEJ)
A
Normal
Esophagus
Sliding hernia
Diaphragm
GEJ
B
Sliding hiatus hernia
Esophagus
Para-esophageal
Diaphragm
GEJ
C
Para-esophagael hiatus hernia

Figure 2.5 Different types of hiatus hernia.

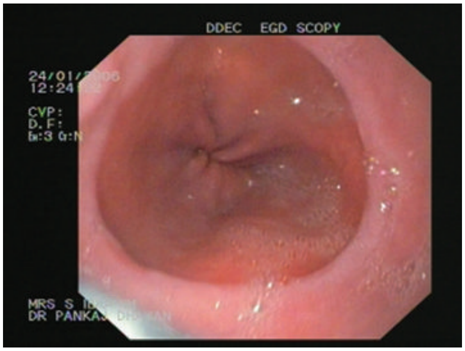
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Figure 2.6 Sliding hiatus hernia (on endoscopy).

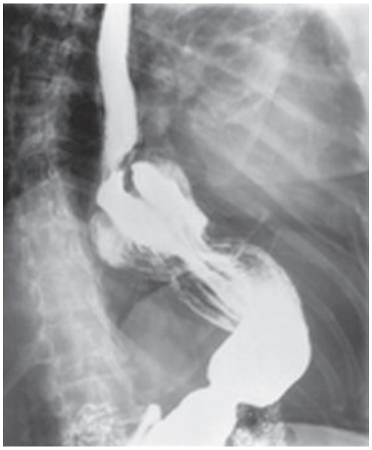


Figure 2.7 Irreducible sliding hiatus hernia with high gastroesophageal junction.

endometritis, salpingitis and inflammatory bowel disease.

c. **Referred pain** – (a) From abdominal viscera which corresponds to the segmental sensory nerve supply of overlying peritoneum (e.g. distension of hepatic and renal capsules causes pain) and (b) from extra-abdominal sources (e.g. acute myocardial infarction, pneumonia, pulmonary infarction, pleurisy, herpes zoster).

d. **Ischemic pain** – Mesenteric angina, splenic infarction, renal infarction and necrosis in hepatoma.

e. **Metabolic** – Diabetic ketoacidosis, hypercalcemic crisis, uremia and acute intermittent porphyria.

f. **Hematological** – Sickle cell crisis, paroxysmal nocturnal hemoglobinuria and hemorrhagic diathesis.

Pain of abdominal origin can radiate to distant areas (Box 2.2).

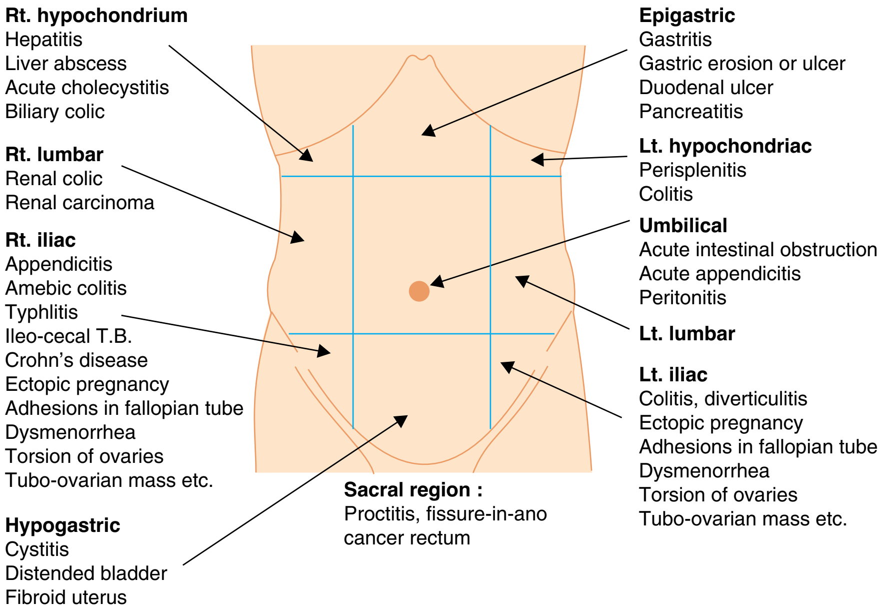

Rt. hypochondrium
Hepatitis
Liver abscess
Acute cholecystitis
Biliary colic
Rt. lumbar
Renal colic
Renal carcinoma
Rt. iliac
Appendicitis
Amebic colitis
Typhlitis
Ileo-cecal T.B.
Crohn's disease
Ectopic pregnancy
Adhesions in fallopian tube
Dysmenorrhea
Torsion of ovaries
Tubo-ovarian mass etc.
Hypogastric
Cystitis
Distended bladder
Fibroid uterus
Sacral region :
Proctitis, fissure-in-ano
cancer rectum
Epigastric
Gastritis
Gastric erosion or ulcer
Duodenal ulcer
Pancreatitis
Lt. hypochondriac
Perisplenitis
Colitis
Umbilical
Acute intestinal obstruction
Acute appendicitis
Peritonitis
Lt. lumbar
Lt. iliac
Colitis, diverticulitis
Ectopic pregnancy
Adhesions in fallopian tube
Dysmenorrhea
Torsion of ovaries
Tubo-ovarian mass etc.

Figure 2.8 Causes of abdominal pain (due to abdominal pathologies) in different quadrants of abdomen.

Radiation of visceral pain **Box 2.2**

■ Pancreas	–	Back
■ Gall bladder	–	Right shoulder
■ Spleen	–	Left shoulder
■ Kidney	–	Flanks
■ Genitourinary	–	Groin

9. Diarrhea – Small bowel diarrhea (large watery stools without mucus or blood) or large bowel diarrhea (small sticky stools with blood, mucus and pus cells).

Causes

a. Infection
  - viral (rotavirus, adenovirus),
  - bacterial (Escherichia coli, salmonella, shigella, Vibrio cholerae),
  - parasitic (Giardia lamblia, Entamoeba histolytica) or
  - fungal infections; food poisoning, traveler's diarrhea,

b. Other causes

Drugs (ampicillin, amoxicillin, laxatives); IBS, ulcerative colitis, Crohn's disease, spurious diarrhea (fecal impaction), malabsorption, steatorrhea (tropical sprue).

10. Constipation – Common causes are dyschesia (bad habit of not going to toilet to ease bowels), low-fiber diet (eating more of nonvegetarian food and less of green vegetables).

GENERAL EXAMINATION OF GI AND HEPATOBILIARY SYSTEMS

- Built, nutrition, body mass index, skinfold thickness
- Pallor, koilonychia, pedal edema
- Jaundice, scratch marks, xanthelasma
- Aphthous ulcers (lips, tongue, oral cavity)
- Glossitis, angular stomatitis, cheilosis
- Bruising, clubbing
- Erythema nodosum, pyoderma gangrenosum
- Dermatitis (pellagra, crazy pavement dermatosis), edema feet, petechiae, ecchymosis, bone tenderness
- Dupuytren's contracture, pigmentation, parotid gland enlargement (Box 2.3, Fig. 2.9)

For examination of mouth, lips, tongue, oral mucosa, teeth, gums, palate and tonsils. See Chapter 1 pages 14–16.

Examination of abdomen

For descriptive and localization of abnormal findings, abdomen is divided into nine quadrants (Fig. 2.10).

Causes of parotid gland enlargement (Fig. 2.9) **Box 2.3**

- Mumps
- Cirrhosis of liver
- Leprosy
- Diabetes mellitus
- Sjögren’s syndrome
- Sarcoidosis
- Leukemia
- Lymphoma
- Parotid calculi
- Postoperative
- Parotid tumors
- Suppurative parotitis

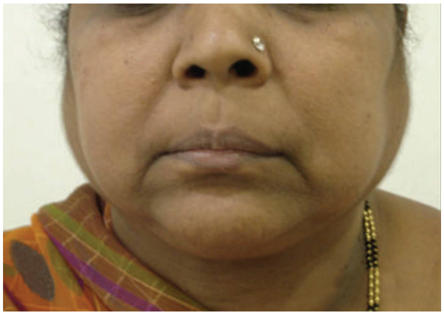
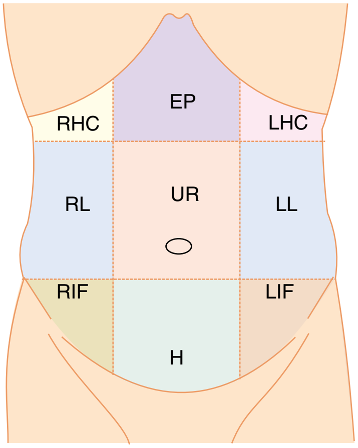


Figure 2.9 Bilateral parotid gland enlargement.



RHC - right hypochondrium
EP - epigastric region
LHC - left hypochondrium
RL - right lumbar
LL - left lumbar
UR - umblical region
RIF - right iliac fossa
H - hypogastric
LIF - left iliac fossa

Figure 2.10 Regions of abdomen.

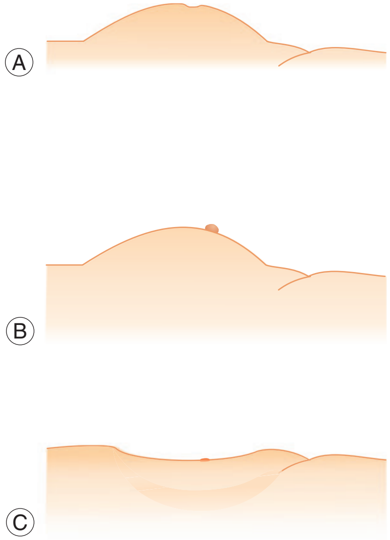


Figure 2.11 (A) Obese abdomen, umbilicus sunken. (B) Distended abdomen, umbilicus everted (ascites). (C) Scaphoid abdomen.

Inspection of abdomen

Ideally, patient should undress and lie supine; cover the patient with a sheet; inspect from nipples to knee joints (for females, bra and under garments are permissible).

1. **Shape of abdomen** (Fig. 2.11)
    - Normal;
    - Obese (umbilicus sunken);
    - Distended: generalized (umbilicus everted), localized;
    - Scaphoid (thin, lean, emaciated)
        a. **Generalized distension of abdomen** – It occurs due to the following five Fs (fat, fluid, fetus, flatus and feces).
            - ❑ Fatty abdomen is protuberant anteriorly with sunken umbilicus (Fig. 2.11).
            - ❑ Fluid (ascites) collects more in flanks with horizontally slit umbilicus (smiling). Dull percussion note in flanks. The distance between xiphoid process and umbilicus is more than the distance between umbilicus and pubic symphysis (Fig. 2.12).
            - ❑ Fetus (pregnancy) and central swellings arising from pelvis (ovarian cyst) result in vertically slit umbilicus with a tympanic note in the flanks. The distance between umbilicus and pubic symphysis is more than the distance between umbilicus and xiphoid process (Fig. 2.13).

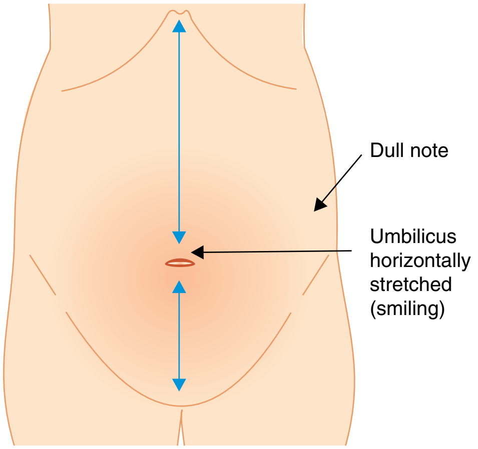


Figure 2.12 The distance between xiphisternum and umbilicus is more than the distance between umbilicus and pubic symphysis.

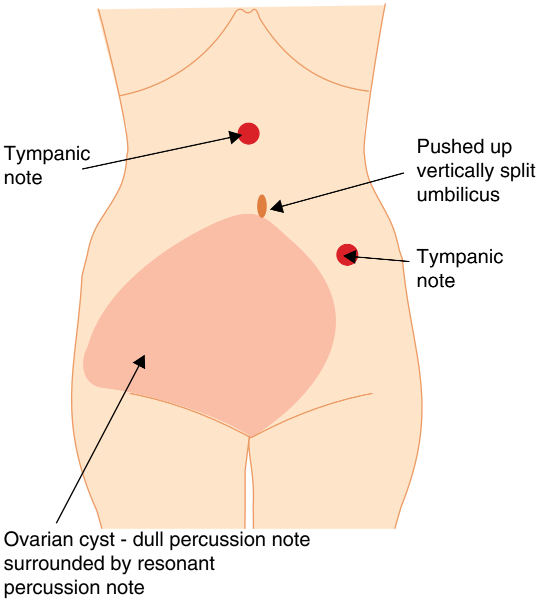

Tympanic note
Pushed up vertically split umbilicus
Tympanic note
Ovarian cyst - dull percussion note surrounded by resonant percussion note

Figure 2.13 Ovarian cyst.

- Flatus may produce distension that is central, localized in flanks or generalized, depending upon the site of intestinal obstruction. Percussion note is tympanic due to distended intestinal loops.
- Feces (impacted) in sigmoid colon cause distension with tympanic percussion note (distended colon).

b. Localized distension – Localized distension or swelling could be due to underlying visceral enlargement.

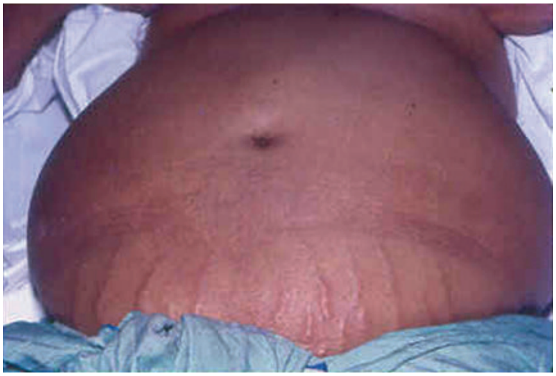


Figure 2.14 Edema of abdominal wall with white striae.

- Liver (right hypochondrium and epigastric regions)
- Spleen (left hypochondrium and umbilical regions)
- Kidneys, lumbar regions
- Ovaries (right or left iliac fossae)
- Distended urinary bladder (hypogastric region)
- Small bowel obstruction (umbilical region)
- Abdominal tumors (depends upon the organ from which tumor is arising)

Also note if the swelling moves freely with respiration (e.g. liver and spleen and tumors arising from stomach move freely with respiration, while tumors arising from posterior structures such as kidneys and lymph nodes move poorly).

2. **Abdominal wall** – Look for edema of the abdominal wall, divarication of recti (post surgery and lax abdomen), metastatic nodules, white or pink striae (Fig. 2.14) (due to recent change in the size of abdomen, e.g. after delivery or removal of intraabdominal tumor or ascitic fluid); linea nigra (seen in pregnancy as midline pigmentation of abdomen below umbilicus). Cushing's syndrome or patients on cortisone therapy may show bluish (purple) striae over the abdomen. Note scars of previous surgeries (large scars) and minimal access surgery (sites of port and a small scar).
3. **Movements of abdomen**
   - **a.** In healthy persons, abdomen bulges during inspiration and retracts during expiration.
   - **b.** In paralysis of diaphragm, movements become paradoxical (bulges in expiration and sinks in inspiration).

   c. In peritonitis, abdominal movements are limited or absent.
4. **Umbilicus** – Examine umbilicus whether it is inverted (normal) or everted (hernia). While coughing, if there is further evertion and bulge with expansile impulse on palpation, diagnosis of umbilical hernia is confirmed. Also note if umbilicus is transversely or vertically slit (Figs. 2.12 and 2.13).
5. **Pulsations** – Notice if there are any visible pulsations in the epigastric region; the causes of epigastric pulsations are as follows:
   a. Abdominal aortic pulsations in thin and lean persons (normal finding)
   b. Expansile pulsations due to aneurysm of abdominal aorta
   c. A swelling (enlarged lymph nodes or carcinoma of stomach) situated anterior to aorta is felt as nonexpansile epigastric pulsations
   d. Right ventricular pulsations in epigastric region in tricuspid regurgitation
   e. Pulsatile liver in tricuspid regurgitation
6. **Visible peristalsis** (see Fig. 2.15 for causes)
   a. Normal in thin persons
   b. Pyloric obstruction (slow wave moving across the abdomen from left hypochondrium to the right side)
   c. Small bowel obstruction (stepladder pattern)
   d. Large intestine obstruction (peristalsis from right to left in the upper abdomen) Peristalsis can be stimulated by gentle stroking, applying cold stimulus or in case of pyloric obstruction asking patient to drink water
7. **Distended veins** – (not just visible) are abnormal. They can be above or below umbilicus and in flanks. The flow of blood in distended veins is tested by emptying a section of vein (by milking it with fingers) and sealing each end of the vein with finger pressure. One finger is lifted and the filling noted. The maneuver is repeated by lifting the other finger while maintaining pressure with first finger. The rapidity of venous filling gives the direction of flow of blood (distended abdominal veins are shown in Fig. 2.16).
   a. Inferior vena cava obstruction – Flow of blood is from below upwards both below and above the umbilicus. Prominent veins may be present in the back also. Abnormal veins become more prominent with patient standing.
   b. Superior vena cava obstruction – Flow of blood is from above downwards in veins both above and below umbilicus.
   c. Portal hypertension (intrahepatic obstruction, e.g. cirrhosis of liver) – Veins are distended around umbilicus (caput medusae) and the flow of blood is away from the umbilicus.
   d. Portal hypertension (extrahepatic portal vein obstruction) – Flow of blood is towards the umbilicus (rarely seen).
8. **Spider nevi** – These are centrally dilated arterioles with radiating capillaries; on pressure by pinhead, spiders blanch and fill up with release of pressure.
9. **Umbilical hernia** – Ask patient to cough or raise his head and shoulders without support to make it prominent.
10. **Divarication** – Divarication of the recti occurs in persons who have had raised intra-abdominal pressure as a result of gross ascites, gross obesity or repeated pregnancies. Abdominal contents protrude when patient raises his head and shoulders.
11. Inspect penis, scrotum for hydrocele, varicocele and undescended testes and look for cough impulse for inguinal and femoral hernias.

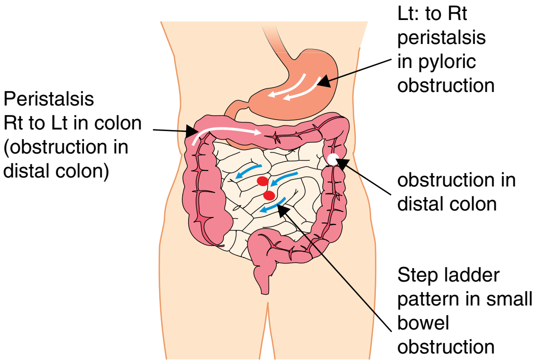
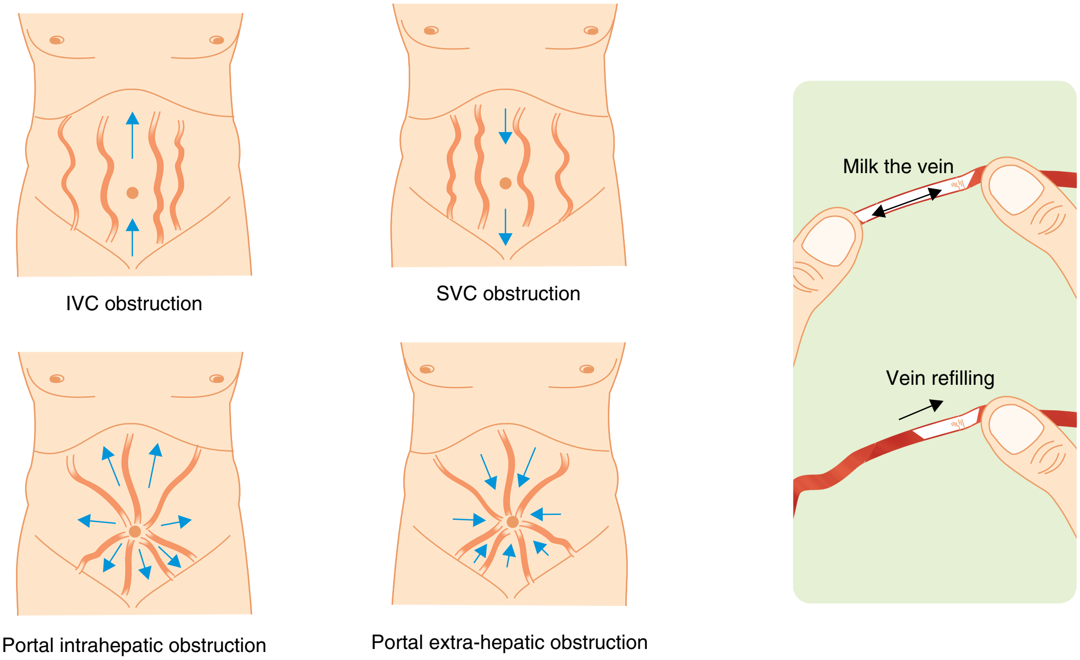

Lt: to Rt peristalsis in pyloric obstruction
Peristalsis Rt to Lt in colon (obstruction in distal colon)
obstruction in distal colon
Step ladder pattern in small bowel obstruction

Figure 2.15 Types and causes of visible peristalsis.

Palpation of abdomen

Ask the patient to lie supine with knees bent or resting over pillow (to relax abdomen), and breathe quietly but a little more deeply than normal with open mouth.

1. **Superficial palpation** – Using the flat of hands (warm your hands in cold weather), start from


IVC obstruction

SVC obstruction

Portal intrahepatic obstruction

Portal extra-hepatic obstruction

Figure 2.16 Distended abdominal veins.

a quadrant away from the site of perceived pathology. Each quadrant is palpated. Note localized tenderness, rigidity or guarding.

2. **Deep palpation**
    - **a.** Palpate more deeply and firmly with the flat of hands.
    - **b.** Use both hands putting the left hand over the right to exert increased pressure, especially in obese or muscular patients.
    - **c.** Divert patient's attention by talking to the patient.
    - **d.** Palpate each quadrant, starting away from the area of pain/tenderness.
    - **e.** Note tenderness, rebound tenderness and rigidity. Palpate for liver, spleen and kidneys (described below). If swelling is felt, ascertain its size, shape, location, consistency, tenderness and movements with breathing, mobility or adherence to adjoining structures.
3. **Dipping method (used in patients with ascites)** – Tap or dip with fingers to displace fluid and feel the organs (liver, spleen, kidneys).
    - **a. Guarding**
        - **i.** It is felt as muscle contraction.
        - **ii.** It is a reaction to underlying visceral inflammation (e.g. cholecystitis – right hypochondrium [RHC], appendicitis – right iliac fossa [RIF]).
        - **iii.** In peritonitis, there is diffuse board-like rigidity.
        - **iv.** The diffuse/generalized guarding may be voluntary (nervous patient).
        - **v.** Localized guarding is more specific of underlying pathology.
    - **b. Tenderness** – Pain felt by the patient on palpation. Deep tenderness is generally due to inflammation or ulceration of underling viscera and the surrounding peritoneum (Box 2.4; Fig. 2.17).
    - **c. Rebound tenderness** – A sign of peritonitis. Rebound tenderness is elicited by exerting firm pressure over viscera, say when you press in left iliac fossa, and then suddenly release the pressure, and if it causes pain over RIF, the test is positive and is suggestive of appendicitis. Sudden release of pressure stimulates inflamed parietal peritoneum, causing pain in the region of inflammation.
4. **Rigidity** – An advanced stage of guarding felt over severely inflamed viscera. It occurs in peritonitis due to perforation of hollow viscus, pancreatitis, cholecystitis, appendicitis and ruptured ectopic gestation. In diffuse peritonitis, rigidity is present all over the abdomen.

Sites of tenderness, guarding in common abdominal diseases — Box 2.4

- Gastric ulcer – Epigastrium in midline
- Duodenal ulcer – Epigastrium to right of midline
- Appendicitis – RIF, McBurney's point (junction of the middle and outer thirds of the line joining the umbilicus to the anterior superior iliac spine)
- Cholecystitis – Right hypochondric region
- Sigmoid diverticulitis – Left iliac fossa
- Pyelonephritis – Renal angle
- Perisplenitis – Left hypochondriac region

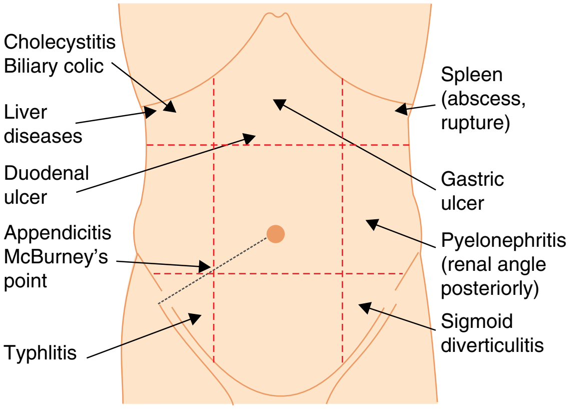


Figure 2.17 Sites and causes of abdominal tenderness.

Examination of liver

Methods for palpation of liver

1. Place right hand well below and parallel to right costal margin and ask the patient to breathe deeply, and feel for the lower border of liver with radial border of index finger of right hand. Move the hand upwards until liver is felt or till right costal margin is reached.
2. Sit on the bed, insert tips of both hands gently below the right costal margin by keeping hands vertically over the abdomen to palpate the liver edge with the patient taking slow deep breaths.
3. Keeping both hands side by side with fingers fanned out and pointing towards right costal margin and epigastrium, use eight fingers as feelers to palpate the lower border of right and left lobes. Move fingers from lateral to medial side to outline the entire lower border. Start from lower abdomen and move upwards so as not to miss edge of grossly enlarged liver.
4. Hooking method is used particularly in obese persons. Hook fingers of both hands below right costal margin directing pressure upwards while patient is taking deep breaths, and palpate liver edge with finger pads.

Examine the surface of liver for nodularity. Measure liver enlargement from costal margin in right midclavicular plane for right lobe and below xiphoid process in the midline for left lobe. Normally, liver edge may be just palpable below the costal margin in deep inspiration.

Practical hints

- In infants, liver is normally palpable.
- Liver is displaced down in emphysema and kyphoscoliosis (on percussion, upper border of liver dullness is displaced down).
- Riedel's lobe may simulate kidney or gall bladder (GB) swelling. It is more common in females.
- Normal liver edge is soft. Firm or hard edge is abnormal.
- Small nodules over liver surface (e.g. cirrhosis of liver) are not easy to appreciate, but large nodules (e.g. metastasis, cysts, hepatoma) can be felt.

Tenderness

Normal liver is painless. Causes of liver tenderness are shown in Box 2.5.

Causes of enlarged tender liver — Box 2.5

- Congestive cardiac failure (CCF)
- Hepatitis (viral, alcoholic, amebic)
- Carcinoma of liver (primary, secondary)
- Amebic liver abscess
- Pyemic liver abscess
- Weil's disease

Causes of enlarged liver (hepatomegaly)

1. **Infections**
   - Bacterial (typhoid, tuberculosis, brucellosis)
   - Viral hepatitis (A, B, C, D, E viruses), infectious mononucleosis
   - Protozoal (amebic abscess, schistosomiasis, malaria, kala-azar)
   - Parasitic (hydatid cyst)

  - Spirochetal (Weil's disease, syphilis)
  - Fungal (actinomycosis)
2. **Congestive hepatomegaly**
   - CCF
   - Constrictive pericarditis
   - Pericarditis with effusion
   - Budd–Chiari syndrome
3. **Cirrhosis (portal, biliary)** (see Table 2.1 for differential features of portal and biliary cirrhosis).
4. **Hematological** – Chronic myeloid leukemia, chronic hemolytic anemia, lymphoma (Hodgkin's, non-Hodgkin's), polycythemia vera, myelofibrosis and hemochromatosis.
5. **Infiltrative disorders**
   - Fatty liver
   - Amyloidosis
   - Gaucher's disease
   - Niemann–Pick's disease
   - Glycogen storage disease.
6. **Toxic** – Alcohol, arsenic.
7. **Tumors** – Primary (carcinoma, sarcoma), secondaries (carcinoma)
8. **Granulomatous disorders** – Tuberculosis, sarcoidosis

Table 2.1 Differential features of portal and biliary cirrhosis

Feature	Portal cirrhosis	Biliary cirrhosis
1. Prevalence	Common	Uncommon
2. Sex	Predominant in men	Predominant in women
3. Jaundice	Mild	Deep
4. Itching	Rare	Common
5. Ascites	Common	Rare
6. Hepatomegaly	Mild	Marked
7. Splenomegaly	Moderate to severe	Mild
8. Clubbing	Rare	Common
9. Serum cholesterol	Normal	High
10. Xanthomas	Absent	May be present
11. Alkaline phosphatase	Normal	High

Examination of spleen

Normal spleen is not palpable. It has to be at least twice its normal size to be just palpable. Spleen is relatively superficial and can be missed with deep palpation. Place right hand over umbilical region with fingers pointing towards the left costal margin and left hand over lower left rib cage posterolaterally. Ask the patient to take deep breath, and simultaneously push left rib cage downward and medially with the left hand. Ask the patient to breath slowly and deeply. In deep inspiration, the tip of the spleen is felt with the tips of fingers of right hand. If it is not palpable in prone position, examine the patient in right lateral position. This bimanual method is used when spleen is just palpable. If splenic enlargement is moderate or marked, feel for consistency, notch on the anterior border and tenderness. In obese persons, one uses hooking method wherein patient lies in right lateral position and examiner stands on the left side behind the patient and hooks fingers of one or both hands under left costal margin to feel spleen in deep inspiration.

Grading of splenomegaly (Fig. 2.18)

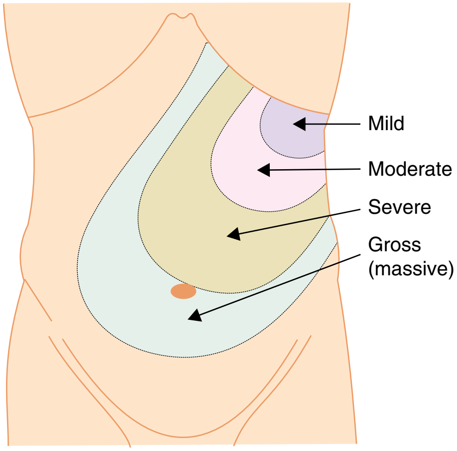


Figure 2.18 Grades of splenomegaly. Mild - just palpable; moderate - midway between costal margin and umbilicus; severe - up to umbilicus; gross - beyond umbilicus.

Causes of massive (gross) splenomegaly – Chronic malaria, chronic kala-azar, chronic myeloid leukemia, myelofibrosis, Felty's syndrome and extrahepatic portal hypertension.

Causes of moderate to severe splenomegaly – Hodgkin's disease, leukemias, lymphomas, polycythemia, hemochromatosis, hemolytic anemia, cirrhosis of liver with portal hypertension, tumors, cysts and causes of massive splenomegaly.

Causes of mild splenomegaly – Typhoid, infective endocarditis, septicemia and tuberculosis.

Examination of kidneys

Kidneys are not normally palpable; however, in thin persons, lower pole of right kidney may be bimanually palpable during deep inspiration. Right kidney is usually lower than left kidney because of liver lying above it. Palpate the kidneys bimanually, right kidney from right side with right hand anteriorly and left hand posteriorly, and vice versa for left kidney. During deep inspiration, one can catch the lower pole of kidney between the two hands. Feel for consistency and tenderness. Test ballotability by pushing kidney from back to the front. Tenderness in renal angle suggests pyelonephritis. See Table 2.2 for differences between enlarged spleen and enlarged left kidney.

Urinary bladder

Distended urinary bladder is visible as an oval-shaped swelling in hypogastric region and can be palpated in the suprapubic region.

Gall bladder

- Normal GB is not palpable.
- Enlarged GB is felt as a firm globular smooth swelling below right costal margin at the level of 9th costal cartilage just lateral to the rectus abdominis.
- It moves freely with breathing.

Table 2.2 **Differences between enlarged spleen and enlarged left kidney**

Spleen	Left kidney
Enlarges mostly downwards and medially towards umbilicus	Enlarges downwards and felt in left lumbar region
Moves freely with respiration	Very little or no movement with respiration
Not palpable bimanually	Bimanually palpable and ballotable
Cannot insert fingers between left costal margin and spleen	Can insert fingers between left costal margin and kidney
Upper border cannot be felt	Upper border may occasionally be felt
Notch often palpable on anterior margin	No notch felt
Does not occupy the renal angle	Occupies renal angle
Dull on percussion	Colonic resonance may be present anteriorly

Murphy's sign – It is useful to diagnose acute cholecystitis. To elicit Murphy's sign, place thumb of left hand below right costal margin at the level of 9th costal cartilage, just lateral to the edge of rectus abdominis, and ask the patient to take deep breath while pressing with the thumb. Patient holds the breath suddenly as the tender GB is felt (positive Murphy's sign).

Courvoisier's law – When obstructive jaundice is secondary to gallstones and chronic cholecystitis, GB cannot distend and hence is not palpable. However, in obstructive jaundice due to carcinoma of the head of pancreas, GB is distended and palpable.

Cecum, appendix, descending colon and sigmoid colon

- Palpate RIF and feel for cecal thickening and tenderness.
- Elicit McBurney's sign (tenderness over McBurney's point) for appendicular pathology.
- Thickening and tenderness in ileocecal region may be due to tuberculosis, Crohn's disease or amebic typhlitis.
- Thickening and tenderness over descending colon and sigmoid colon suggest colitis (amebic, ulcerative). In a constipated patient, fecal mass in pelvic colon can be confused with a mass. The fecal mass disappears after enema.
- Normally, transverse colon is difficult to feel but carcinoma of colon is felt as a firm/hard mass.
- Normally, descending colon (rectosigmoid) can be palpated. Sometimes cecum is also palpable.

Percussion of abdomen

- Percuss for lower border of liver to confirm its enlargement. Enlargement of right lobe of liver is measured below right costal margin in right midclavicular plane and enlargement of left lobe is measured below xiphoid process in mid sternal plane.
- Percuss for upper border of liver to ascertain whether liver is enlarged or displaced down.
- Percuss for lower border of spleen to confirm its enlargement
- Percuss for band of colonic resonance in situation of enlarged left kidney

- Percuss for urinary bladder in situation of distended urinary bladder
- Percuss to confirm presence of ascites.

Signs of ascites are fluid thrill, shifting dullness, horseshoe-shaped dullness and puddle sign.

Fluid thrill

It is present in tense ascites. Ask the patient or an assistant to keep ulnar border of his hand firmly over abdomen in the midline, then tap one flank with finger of one hand when a fluid thrill is felt by the other hand placed on the other side of abdomen.

Horseshoe-shaped dullness

In moderate ascites, horseshoe-shaped dullness can be elicited (Fig. 2.19).

Shifting dullness

1. First confirm dullness in both flanks with patient in supine position. Start percussion from midline, keeping pleximeter finger along the long axis of abdomen parallel to fluid level towards a flank till a dull note is elicited. Keeping the pleximeter finger at the same place, turn the patient to the opposite side (fluid will shift to opposite side) and percuss at the same spot when tympanic note is elicited as the floating intestines occupy the flank. Repeat the same maneuver by eliciting shifting dullness on the opposite flank. This confirms the presence of free fluid.
2. If the amount of fluid is less, shift the fluid from both flanks to one side, elicit dull note on that side and then turn patient through 180° to other side and elicit tympanic note at the same spot.
3. If the amount of fluid is very less, one can elicit puddle sign in which one tries to shift the fluid not only from both flanks but also from Douglas pouch and elicits dull note below umbilicus in midline while patient is in knee elbow position. Keeping pleximeter finger fixed, change the patient's position to supine. With the fluid moving back and intestines coming up at the spot, tympanic note is elicited.

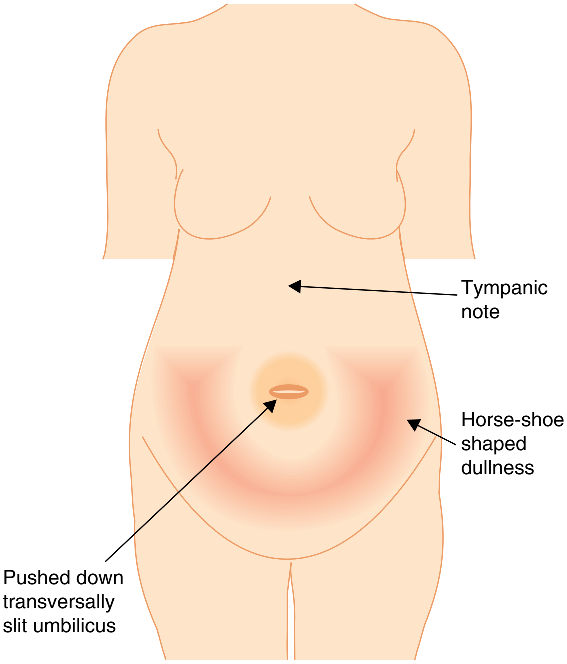

Tympanic note
Horse-shoe shaped dullness
Pushed down transversally slit umbilicus

Figure 2.19 Ascites.

Auscultation of abdomen

1. **Intestinal sounds** – Normal intestinal sounds are low to medium pitched with only an occasional tinkle or high pitch. In mechanical intestinal obstruction, frequent loud intestinal sounds are heard (borborygmi). In acute abdomen due to peritonitis, intestinal sounds are either not audible or poorly audible (silent abdomen). Management of both these causes of acute abdomen is different; hence, auscultation is important.
2. **Bruit** – Bruit or murmur may be present over abdominal aorta and its branches. Areas to auscultate are above and to left of umbilicus for abdominal aorta, iliac fossa for iliac artery, groins for femoral arteries and paramedian areas of umbilicus for renal arteries. Bruit over epigastric area denotes affection of celiac axis or mesenteric artery. A bruit may be present over liver if a patient has hepatoma or hemangioma (Fig. 2.20).
3. **Venous hum** – Venous hum is audible along ligamentum teres (between umbilicus and liver) due to opening of paraumbilical veins in cases of severe portal hypertension due to liver cirrhosis **(Cruveilhier–Baumgarten syndrome)**. At birth, left umbilical vein and ductus venosus retrogress into ligamentum teres and ligamentum venosum, respectively. Both join left branch of portal vein. In severe portal

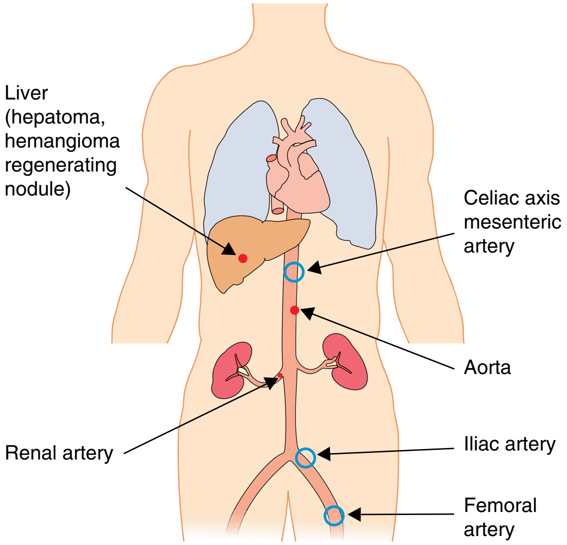

Liver (hepatoma, hemangioma regenerating nodule)
Celiac axis mesenteric artery
Aorta
Renal artery
Iliac artery
Femoral artery

Figure 2.20 Sites of abdominal bruit.

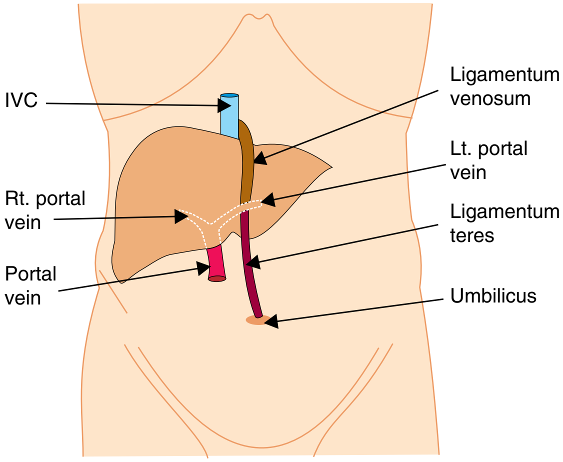


Figure 2.21 Shows ligamentum teres joining left portal vein and ligamentum venosum extending from left portal vein to inferior vena cava.

hypertension, umbilical veins open up and one can hear a venous hum between umbilicus and right lower costal border (Fig. 2.21).

4. **Splenic rub** – In perisplenitis which is very occasionally present in severe septicemia, splenic abscess or infective endocarditis (splenic infarction), one may hear friction rub over enlarged spleen. Patient feels pain on breathing, which may be referred to the left shoulder.
5. **Hepatic rub** – Hepatic rub is sometimes heard in perihepatitis and liver malignancy.
6. **Succussion splash** – This can be elicited in patients with dilated stomach (secondary to pyloric obstruction).
7. **Uterine souffle** – Uterine souffle and fetal heart sounds are recorded over pregnant uterus.

Inguinal hernia and inguinal glands

In supine position, look for any swelling along inguinal canal, particularly when patient coughs. Then place hands over inguinal canals with fingers pointing towards pubic symphysis and feel for an expansile impulse on loud cough. Finally, the same maneuver is repeated with patient standing. One can usually feel intestinal loops as hernial contents. Inguinal hernia may be direct (lump coming out from inguinal canal) or indirect (hernia sac coming out from inguinal ring).

Femoral hernia is less common and should be differentiated from inguinal hernia by placing the index finger on pubic tubercle, hernial sac of inguinal hernia lies medial to and above finger and that of femoral hernia lies lateral to and below the finger.

Palpate for inguinal glands (horizontal group along inguinal grooves and vertical group along femoral arteries) (see Fig. 1.26). If enlarged, determine the usual characteristics (size, number, discrete, matted, consistency, tenderness). Important causes of inguinal lymph node enlargement are tuberculosis, filariasis, secondaries and lymphoma.

Palpate and auscultate femoral arteries.

Male genitalia

Look for any scrotal swelling. Palpate the swelling to determine whether it is restricted to scrotum (one can get above the swelling) or inguinoscrotal (one cannot get above the swelling). Swellings restricted to scrotum arise from testis, epididymis or spermatic cord. By palpation, one should determine whether swelling is solid or cystic and whether testes can be felt separately from the swelling. Positive transillumination test confirms the swelling to be cystic (spermatocele or hydrocele).

Varicocele is due to varicosity of pampiniform and cremasteric venous plexi. Varicocele is more prominently seen in standing position and is soft to feel.

Anus and per rectal examination

It is important to examine anus and to perform rectal examination at the end of abdominal examination.

CLINICAL CASES

A case of cirrhosis of liver

1. **Definition** – Cirrhosis of liver is progressive fibrosis with distortion and disorganization of hepatic architecture and regeneration with nodule formation.
2. **Etiology**
   - a. **Common causes** – The causes are chronic viral hepatitis (HBV with or without HDV coinfection and HCV) and alcohol. In India, HBV accounts for 50–70% of cases, with HCV being the next common cause. Overall globally alcohol is responsible for over 50% of the cases. Alcoholics in India have high prevalence of HBV infection.
   - b. **Other causes** – Cryptogenic (idiopathic), autoimmune hepatitis, malnutrition, Indian childhood cirrhosis, primary biliary cirrhosis, metabolic causes (Wilson's disease, hemochromatosis, glycogen storage disease, α-1 antitrypsin deficiency, diabetes mellitus, galactosemia, Fanconi's syndrome), chronic venous outflow obstruction (CCF, Budd–Chiari syndrome, veno-occlusive disease, constrictive pericarditis), drugs (methotrexate, amiodarones) and schistosomiasis (an important cause in African countries).
3. **Histopathological classification**
   - a. Micronodular (portal cirrhosis)
   - b. Macronodular (postnecrotic cirrhosis)
4. **Clinical features** (see Fig. 2.22)
5. **Investigations**
   - a. Liver function tests (LFTs) – Tests may be normal in compensated stage. Abnormalities are
     - i. Low serum albumin, elevated serum globulin, altered albumin–globulin ratio.
     - ii. Elevated SGOT, SGPT and gamma-GT (particularly in alcoholic liver cirrhosis).
     - iii. Increased serum alkaline phosphatase in biliary cirrhosis or sclerosing cholangitis.
   - b. Hematological tests – Anemia may be normocytic, microcytic hypochromic (chronic GI blood loss) or macrocytic. Leukopenia with low platelet count occurs with hypersplenism. Prolonged prothrombin time is a sensitive marker of hepatocellular dysfunction.
   - c. HBV, HCV and HDV viral markers.
   - d. Decreased ceruloplasmin, increased urinary and plasma copper levels are seen in Wilson's disease.
   - e. Increased serum iron and increased transferrin saturation (greater than 50%) are seen in hemochromatosis.
   - f. Alpha-1 antitrypsin deficiency is found in some cases.
   - g. Antinuclear antibodies are present in autoimmune hepatitis.
   - h. Serial serum ammonia and glutamate levels (in patients with hepatic encephalopathy) are measured to monitor the progress.

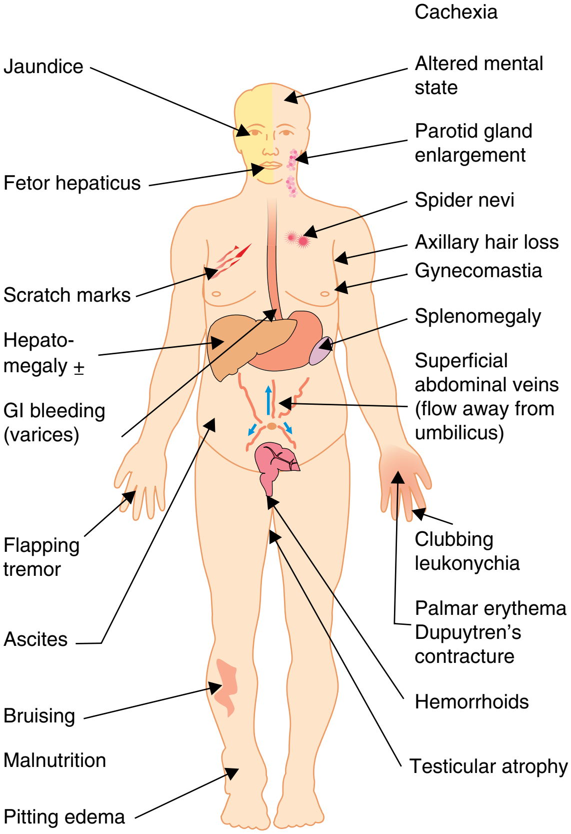

Cachexia
Jaundice
Altered mental state
Parotid gland enlargement
Fetor hepaticus
Spider nevi
Axillary hair loss
Gynecomastia
Scratch marks
Splenomegaly
Hepato-megaly ±
Superficial abdominal veins (flow away from umbilicus)
GI bleeding (varices)
Flapping tremor
Clubbing leukonychia
Palmar erythema Dupuytren's contracture
Ascites
Hemorrhoids
Bruising
Malnutrition
Testicular atrophy
Pitting edema

Figure 2.22 Clinical features in chronic liver disease.

i. Ultrasound of abdomen helps to detect hepatosplenomegaly, ascites, fatty liver, carcinoma liver and varices.
j. CT scan or MRI is done to diagnose hemochromatosis; MRI is more sensitive.
k. Radionuclide liver scan (technetium-99m sulfur) typically shows irregular liver uptake with increased spleen and bone marrow uptake.
l. Barium swallow is done for esophageal varices (Fig. 2.23).
m. Endoscopy (diagnostic and therapeutic for esophageal and gastric varices) is indicated if upper GI bleed occurs (Figs. 2.24 and 2.25).
n. Ascitic fluid examination.
    i. Typically transudate (protein less than 2.5 g/dl and few cells). High serum to ascites albumin concentration gradient (greater than 1.1 g/dl).
    ii. Exudate with secondary infection.

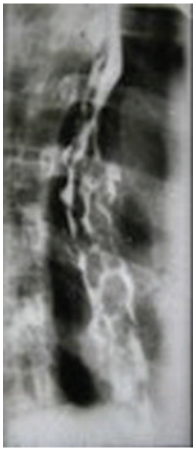


Figure 2.23 Serpentine filling defects in the esophagus due to esophageal varices.

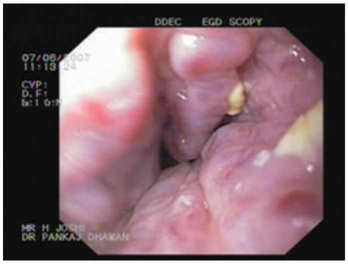


Figure 2.24 Esophageal varices (on endoscopy).

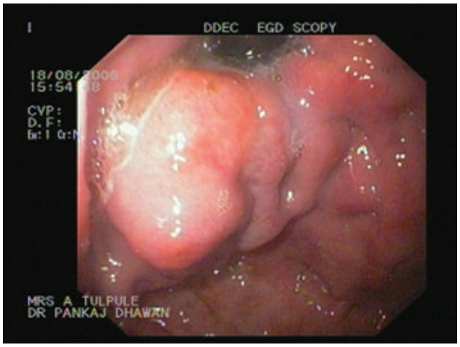


Figure 2.25 Gastric varices (fundus) (on endoscopy).

        ❑ With tuberculosis, lymphocytic exudate with increased adenosine deaminase.
        ❑ With spontaneous bacterial peritonitis, ascitic fluid protein is less than 1 g/dl with polymorph greater than 250/mm^3.
        ❑ With pancreatitis, amylase levels are elevated in ascitic fluid.
        ❑ With malignancy, cytology for malignant cells.
o. Liver biopsy for confirming the diagnosis (refer procedures; transjugular or laproscopic biopsy if percutaneous biopsy is contraindicated).
p. Patients with cirrhosis due to HBV, HCV or hemochromatosis should be screened for hepatocellular carcinoma (HCC) with periodic alpha-fetoprotein [α-FP] estimation and ultrasound examination of abdomen.

6. Complications
    a. **Hematemesis** – It occurs mostly due to rupture of esophageal varices (Figs. 2.23 and 2.24) and sometimes due to gastric varices (Fig. 2.25), peptic ulcer, erosive and congestive gastropathy.
    b. **Hepatic encephalopathy** – It occurs due to hepatocellular failure with portosystemic shunting of blood.
    c. **Hepatorenal syndrome** – In 30–40% patients of cirrhosis with ascites, renal failure due to decreased renal perfusion occurs over 2–5 years. There is progressive oliguria, rise in creatinine and blood urea, hyponatremia (dilutional) and hyperkalemia. Prognosis is poor (majority die within a few months).

   - **d. Hepatocellular carcinoma** – It develops in 15–25% of liver cirrhosis cases, particularly with hepatitis C (90–100%) or B infection.
   - **e. Spontaneous bacterial peritonitis** – It occurs in low-protein ascitic fluid due to low-grade bacteremia existent in cirrhotics. This is different from secondary bacterial peritonitis.

7. **Management of cirrhosis liver**
   - **a.** Stop alcohol consumption.
   - **b.** Restrict salt intake (less than 3 g/day) in the presence of ascites and edema.
   - **c.** High protein diet (1 g/kg BW).
   - **d.** Essential amino acids are of no value.
   - **e.** In primary biliary cirrhosis – ursodeoxycholic acid (oral 12–15 mg/kg/day) decreases liver damage.
   - **f.** In Wilson's disease – D-penicillamine and trientine hydrochloride are helpful.
   - **g.** In hemochromatosis – iron chelation.
   - **h.** In viral (B or C +ve) – antiviral agents are recommended.
   - **i.** In the presence of ascites low-sodium high-protein diet, diuretics (loop) and spironolactone (aldosterone antagonist) are recommended.
8. **Management of serious complications**
   - **a.** Hematemesis due to variceal bleeding. For varices, banding through endoscopy, sclerotherapy or transjugular intrahepatic portosystemic shunting (TIPS) are the options.
   - **b.** For patients with hepatic encephalopathy (patient in coma), the following are the guidelines for management.
     - **i.** Preferably treat in ICU.
     - **ii.** Identify and treat precipitating factors (bleeding, infection, electrolyte disturbances).
     - **iii.** Omit diuretic therapy.
     - **iv.** Stop proteins, later as patient recovers from coma and is able to eat, start dietary protein (1 g/kg BW), only vegetable proteins and no animal proteins.
     - **v.** No alcohol.
     - **vi.** Correct electrolyte disturbances, maintain intake/output chart, monitor urine output, give IV glucose 300 g/dl, start and repeat if required.
     - **vii.** Oral ampicillin and metronidazole to sterilize the gut (bacteria produce ammonia), oral neomycin is not advocated as it can lead to renal failure.
     - **viii.** Control GI bleeding (if present).
     - **ix.** No sedatives.
     - **x.** Oral lactulose 10 g, 4–6 times daily, results in 2–3 soft motions/day. Alternatively, lactose (cheaper and equally effective) can be used.
     - **xi.** Colonic wash with acidifying solutions like lactose or mannitol.
     - **xii.** Alpha dopa, bromocriptine and branched-chain amino acids have been used with variable results. Flumazenil (benzodiazepine antagonist) has some beneficial effects.
     - **xiii.** Hemoperfusion.
     - **xiv.** Liver transplant for patients with fulminant hepatic failure.
9. **Prognosis of cirrhosis liver** – It depends upon disease state (compensated or decompensated), etiology and comorbid conditions. Over a variable period, patients become decompensated (five years of survival amongst 20% in decompensated state as against 50% survival in compensated state). Continued consumption of alcohol (even small amounts) carries very poor prognosis.

Viva voce

Q1. What are the causes of rapid worsening of ascites in a stable cirrhotic patient?

- Spontaneous bacterial peritonitis
- Alcoholic binge
- GI hemorrhage leading to rapid deterioration of liver function
- Electrolyte disturbances (hypokalemia)
- Budd–Chiari syndrome (hepatic venous thrombosis)
- Hepatoma
- Sepsis

Q2. What is Cruveilhier–Baumgarten syndrome?

It is seen in liver cirrhosis with severe portal hypertension, ascites, splenomegaly, varices, dilated abdominal veins around umbilicus (caput medusae) with flow of blood away from umbilicus. On auscultation, venous hum is heard over dilated paraumbilical veins that open up due to elevated portal pressure (Fig. 2.21).

Q3. What are the features of hepatic decompensation that indicate poor prognosis?

- Refractory ascites – More tense the ascites, worse the prognosis.
- Renal failure – More severe the renal failure worse is the prognosis
- Serum albumin – Lower the albumin, worse the prognosis
- Serum bilirubin – Higher the levels, worse the prognosis
- Prothrombin time (PTT) – Prognosis worsens as PTT increases
- Encephalopathy – Deeper the coma, worse the prognosis
- Large varices with bleeding worsen the prognosis.
- Presence of viral markers (B or C) worsen prognosis
- Development of HCC worsen prognosis

Q4. What are the precipitating factors causing hepatic coma?

- GI bleed
- Electrolyte disturbances
- Constipation
- High protein diet
- Ascitic tapping or any other procedure
- Sedatives
- Secondary infection
- Excessive diuresis
- Portocaval shunt surgery

Q5. What is the mechanism of hepatic coma?

Ammonia is the important neurotoxin, others being mercaptans and phenolic compounds. Hyperammonemia depletes glutamate (the most important excitatory neurotransmitter). Secondly, increased levels of aromatic amino acids because of lowering of branched-chain essential amino acids (valine, leucine and isoleucine) have adverse effects.

Q6. How does GI bleeding present?

Hematemesis (Fig. 2.1); hematochezia, passage of gross blood per rectum (Fig. 2.4); melena (occult blood).

Q7. What are the causes of black stools?

- Upper gastrointestinal bleeding (occult blood)
- Iron and bismuth ingestion
- Charcoal, licorice, black berries

Q8. How does alcoholic liver disease manifest?

- Fatty infiltration (steatosis)
- Alcoholic hepatitis
- Micronodular cirrhosis of liver
- Hepatic siderosis
- Hepatocellular carcinoma

A case of ascites

1. **Common causes of ascites (Fig. 2.26)** – Cirrhosis of liver, CCF, nephrotic syndrome, hypoproteinemia, pericardial effusion, constrictive pericarditis, epidemic dropsy, Meig's syndrome, peritonitis (tuberculous) and Budd–Chiari syndrome (hepatic vein thrombosis).
2. **Symptoms**
   - **a.** Distension of abdomen
   - **b.** Dyspnea with massive ascites
   - **c.** Edema over legs (CCF, cirrhosis liver, nephrotic syndrome, hypoproteinemia)
3. **Signs of ascites** (see page 41)
4. **Investigations**
   - **a.** Ultrasonography – In addition to ascites, look for liver or spleen enlargement or any other mass
   - **b.** CT abdomen for better visualization of the pathology
   - **c.** Diagnostic ascitic aspiration to confirm whether exudate or transudate (see page 44)
   - **d.** Ultrasound-guided liver biopsy or fine-needle aspiration cytology of lymph nodes
5. **Principles of treatment**
   - **a.** Bed rest
   - **b.** Restricted salt, high protein diet, restricted fluid intake (1 litre)
   - **c.** Diuretics (furosemide + spironolactone)
   - **d.** In massive ascites, large amount (3–5 litres) of fluid is aspirated in one sitting with IV infusion of salt-free albumin of 6–8 g/litre

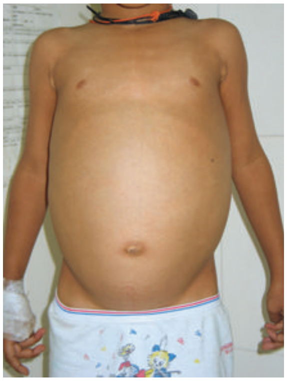


Figure 2.26 Ascites with everted umbilicus and gynecomastia.

   e. Peritoneovenous shunt (Le Veen shunt) in refractory ascites in which ascitic fluid is drained directly into internal jugular vein
   f. Transjugular intrahepatic porto-systemic stent shunting TIPSS useful in refractory ascites in liver cirrhosis
   g. Treatment of underlying cause

Viva voce

Q1. What are the causes of chylous ascites?

Chylous ascites is due to lymphatic obstruction in abdomen caused by trauma, filariasis, lymphoma, carcinoma, cirrhosis of liver, tuberculosis, nephrotic syndrome and pancreatitis.

Q2. What are the mechanisms of formation of ascites in cirrhosis of liver?

- Hypoalbuminemia (low oncotic pressure)
- Raised portal pressure (raised hydrostatic pressure)
- Raised antidiuretic hormone levels
- Raised aldosterone levels (reduced degradation of aldosterone)
- Lymphorrhea (hepatic and splenic lymph spillover)

A case of hepatosplenomegaly

1. **Causes** – Causes of hepatosplenomegaly are almost the same as those of hepatomegaly (see pages 38–39).
2. **Clinical features** – Physician takes detailed history keeping in mind the causes of hepatosplenomegaly mentioned. Details of history of fevers, investigations and treatment carried out are helpful.

   On physical examination, apart from noting details of liver and spleen enlargement, a thorough general examination to detect signs of hepatocellular failure, portal hypertension or manifestations of underlying cause needs to be carried out, e.g.
   a. Pallor (hemolytic anemia, thalassemia, liver cirrhosis)
   b. Jaundice (liver cirrhosis, infective hepatitis, hemolytic anemia)
   c. Lymph nodes (lymphoma, lymphatic leukemia)
   d. Butterfly rash over cheeks (systemic lupus erythematosus)
   e. Plethoric face (polycythemia)
   f. Palmar erythema, spider nevi (liver cirrhosis)
   g. Sternal tenderness (chronic myeloid leukemia)
   h. Tremors with Kayser–Fleischer (KF) rings (Wilson's disease)
   i. Petechiae (infective endocarditis, acute leukemia)
3. **Investigations** – To ascertain the etiopathology, following investigations are carried out.
   a. CBC
      i. Leukocytosis (leukemia, infection)
      ii. Leukopenia (malaria, kala-azar, enteric fever, infectious mononucleosis)
      iii. Pancytopenia (hypersplenism, acute leukemia)
      iv. Reticulocytosis (hemolytic anemia)
   b. Peripheral smear (malarial parasite, Leishmania donavani bodies, spherocytes)
   c. Widal test and blood culture (typhoid)
   d. Bone marrow examination (leukemias, lymphomas, Gaucher's disease).
   e. Ultrasonography of abdomen for confirming size of liver, and presence of splenomegaly, ascites and lymph nodes
   f. CT scan of chest and abdomen for lymph nodes
   g. Lymph node biopsy.
   h. Liver biopsy for liver cirrhosis and hepatoma.
   i. Splenic puncture for parasitic diseases (kala-azar)
   j. Mantoux test or TB Gold test for tuberculosis.
   k. Skull X-ray (thalassemia), "hair on end" appearance.
   l. Chest X-ray to rule out tuberculosis and mediastinal lymph nodes.

A case of hepatomegaly

See page 38 for causes. Work up as for the case of hepatosplenomegaly.

A case of splenomegaly

See page 39 for causes. Work up the same way as for a case of hepatosplenomegaly.

Viva voce

Q1. What is Banti's disease?

There is splenomegaly with portal hypertension. Splenomegaly is due to abnormal splenic or portal blood flow. The causes are cirrhosis of liver, hepatic vein obstruction, portal vein obstruction, splenic vein obstruction, splenic artery aneurysm, schistosomiasis or echinococcosis of liver.

A case of jaundice

Jaundice (Fig. 2.27) is classified as

1. Hemolytic
2. Hepatocellular
3. Cholestatic (obstructive), which may be extrahepatic or intrahepatic, including hepatocellular
4. Congenital hyperbilirubinemias due to disorders of bilirubin metabolism.

1. **Hemolytic jaundice** – It is due to excessive hemolysis, and there is increased serum levels of unconjugated bilirubin which is not water soluble; hence, it does not pass into urine. Urinary urobilinogen is increased. Liver function tests are normal. Jaundice is mild (serum bilirubin is 4–6 mg). Serum alkaline phosphatase, serum albumin and liver enzymes are normal. The causes of hemolytic jaundice are same as the causes of hemolytic anemia (see Chapter 8).
2. **Hepatocellular jaundice** – It occurs usually due to hepatitis viruses A, B, C, D, E, or G, alcohol, hepatotoxic drugs or cirrhosis of liver (of any etiology). Due to liver cell damage, there is impaired bilirubin metabolism and transportation. Liver function tests are deranged. Clinical findings will depend upon the underlying cause.
3. **Cholestatic (obstructive) jaundice** – It can be extrahepatic (due to bile duct obstruction) or intrahepatic (due to liver cell dysfunction or cholestasis in bile canaliculi). The causes are
   - **a.** Extrahepatic
     - **i.** Biliary duct stone(s)
     - **ii.** Tumors of biliary tract (benign, malignant)
     - **iii.** Stricture of bile duct
     - **iv.** Carcinoma head of pancreas
     - **v.** Pancreatitis
     - **vi.** Pseudopancreatic cyst
   - **b.** Intrahepatic
     - **i.** Viral hepatitis
     - **ii.** Alcoholic hepatitis
     - **iii.** Cirrhosis of liver
     - **iv.** Hepatotoxic drugs, toxins
     - **v.** Primary biliary cirrhosis, sclerosing cholangitis
     - **vi.** Cholestasis of pregnancy
4. **Congenital hyperbilirubinemias**
   - **a. Unconjugated hyperbilirubinemias**
     - **i. Gilbert's syndrome** – This is the commonest type of congenital hyperbilirubinemia. It is an autosomal dominant disorder. It is asymptomatic and detected incidentally when serum bilirubin (unconjugated) is found to be mildly raised (2–4 mg/dl). Other liver function tests are normal. Patient has to be reassured that it is a benign condition and usually no treatment is necessary.
     - **ii. Crigler–Najjar syndrome** – There are two types of this condition, Type I and II. In Type I (autosomal recessive), there is total absence of glucuronyl transferase. Patient has very high unconjugated bilirubin (greater than 20 mg/dl). This can be seen in neonates who develop kernicterus. It is a fatal condition. In Type II (autosomal dominant), which is also a serious disorder, there is reduced glucuronyl transferase with increased unconjugated bilirubin (8–20 mg/dl). Kernicterus is rare, and the child can live up to adult age. It is treated by phenobarbitone, UV rays or liver transplant.
   - **b. Conjugated bilirubinemias**
     - **i.** Dubin–Johnson syndrome (autosomal recessive)
     - **ii.** Rotor syndrome (autosomal dominant)

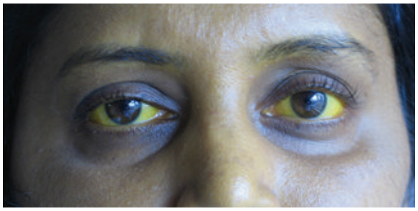


Figure 2.27 Severe jaundice.

Both may present at any age. There is defect in canalicular transport of bilirubin. In Dubin–Johnson syndrome, serum bilirubin levels are high (up to 25 mg/dl), whereas in Rotor syndrome, serum bilirubin levels are low (less than 10 mg/dl). Prognosis is good in both, and usually no treatment is required.

Usually, a case of obstructive (cholestatic), hemolytic or hepatocellular jaundice is kept for practical examination.

See Boxes 2.6–2.8 for salient features of obstructive, hemolytic and hepatocellular jaundice.

Salient features of obstructive jaundice

Box 2.6

- Deep yellow or greenish yellow (due to biliverdin) in color
- Skin marks of scratching due to pruritis
- Sinus bradycardia
- Ecchymoses
- Bitot's spots (vitamin A deficiency)
- Xanthelasma, xanthoma
- Thrombophlebitis (carcinoma of pancreas causing obstructive jaundice)
- Arcus senilis and clubbing (primary biliary cirrhosis)
- Urine – Bilirubin+, bile salts+, urobilinogen absent
- Blood – Raised conjugated bilirubin with raised alkaline phosphatase

Salient features of hemolytic jaundice

Box 2.7

- Lemon yellow color icterus
- Pallor
- Splenomegaly
- Prominent cheek bones, frontal bossing (thalassemia major, sickle cell anemia)
- Leg ulcers and gallstones in chronic cases
- Urine – Urobilinogen++, bile salts and bilirubin absent
- Blood – Raised unconjugated bilirubin with normal alkaline phosphatase
- Positive Coombs' test (autoimmune hemolytic anemia)

Salient features of hepatocellular jaundice

Box 2.8

- Mild jaundice in early stages, deep jaundice in terminal stage
- Palmar erythema, spider nevi, Dupuytren's contracture, gynecomastia, testicular atrophy indicate cirrhosis liver particularly alcoholic
- Fever indicates hepatitis, cholangitis
- KF rings (Wilson's disease)
- Wasting, loss of weight, lymphadenopathy (look for underlying malignancy, lymphoma)
- Raised SGOT, SGPT, gamma-GT and total bilirubin (conjugated bilirubinemia)

Abdomen

- Distension – generalized (ascites), localized due to hepatoma or other tumors
- Hepatomegaly (hepatitis, postnecrotic cirrhosis of liver, hepatocellular carcinoma)
- Splenomegaly (portal hypertension, hemolytic anemia)
- Enlarged palpable gall bladder indicates extrahepatic obstruction (Courvoisier's law), Murphy's sign positive only with inflammation
- Epigastric lump – Left lobe of liver, gastric carcinoma, choledochal cyst and biliary tract malignancy
- Surgical scars (cholecystectomy)

Laboratory investigations

- Ultrasound of abdomen for liver size, tumors, splenomegaly, pancreatic pathology
- Spiral CT of abdomen for more details
- Magnetic resonance cholangio-pancreatography
- ERCP (endoscopic retrograde cholangio-pancreatography for bile duct stone, tumor)
- Upper GI endoscopy for carcinoma stomach

Management

It depends upon the underlying cause.

Viva voce

Q1. What are the differences between extrahepatic and intrahepatic biliary obstruction?

The differences between extrahepatic and intraheptaic biliary obstruction are given in the following Table 2.3

Table 2.3 Differences features of extrahepatic and intrahepatic obstruction

	Extrahepatic obstruction	Intrahepatic obstruction
Fever	+	–
Prodrome	–	+
Abdominal pain	+	–
History of abdominal surgery	+	–
Hepatotoxic drugs	–	+
Alcohol ingestion	–	+
Blood transfusion	–	+
Features of liver cirrhosis	–	+
Palpable GB	+	–
Abdominal lump	+	–
Effect of vitamin K on prolonged PT	corrects	does not correct

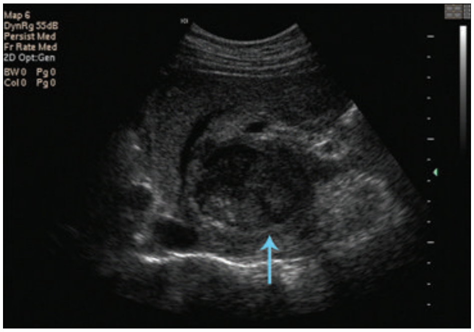


Figure 2.28 Ultrasonography of abdomen showing amebic liver abscess.

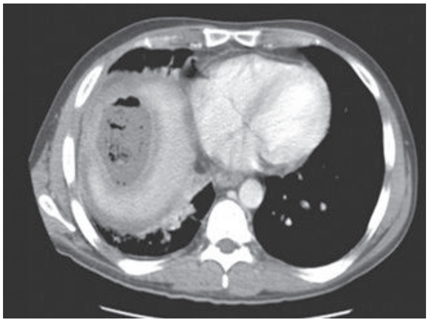


Figure 2.29 CT scan of abdomen showing amebic liver abscess.

A Case of amebic liver abscess

1. **Introduction** – Amebic liver abscess is the most common extraintestinal form of amebiasis. It is common in men (M:F = 10.1) because of alcohol abuse. Usually occurs in young adults.
2. **Clinical features** – It presents with history of high fever with pain in right hypochondriac or epigastric region (left lobe abscess). Pain may radiate to tip of right shoulder. There is either past history of amebiasis or present history of diarrhea with mucus.

   Jaundice may be present in large abscess or with multiple abscesses. Liver is enlarged and tender. Upper border of liver dullness is shifted upwards.

   There is tenderness over lower intercostal spaces on the right side. One can elicit tenderness of liver by thumping with a fist over right and left lower parts of the chest, and comparing the difference.
3. **Investigations**
   - **a.** Chest X-ray shows raised right leaf of diaphragm and blunting of right costophrenic angle.
   - **b.** Polymorphonuclear leukocytosis.
   - **c.** Stool examination for *Entamoeba histolytica* cysts or trophozoites.
   - **d.** Ultrasonography to assess size, site and number of abscesses (Fig. 2.28).
   - **e.** CT scan abdomen if ultrasonography is unsatisfactory (Fig. 2.29). (Note – Figs. 2.28 and 2.29 are of different patients.)
   - **f.** Serology – Indirect hemagglutination (IHA) test is nowadays replaced by ELISA test or indirect fluorescence antibody test. Serological tests are positive in 90% of cases.
   - **g.** Diagnostic/therapeutic tapping (ultrasound or CT guided). Typical chocolate color (anchovy sauce) pus suggests amebic etiology (confirmed by demonstration of trophozoites in the pus, but these are rarely seen).
4. **Complications**
   - **a.** Rupture into pleura, lung, pericardium or peritoneum.
   - **b.** Secondary bacterial infection

Viva voce

Q1. How will you manage a case of amebic liver abscess?

Majority of patients can be managed medically by treatment with tissue amebicide (metronidazole, 400 mg tds) for 7–10 days, followed by luminal amebicide (diloxanide furoate 500 mg tds) for 7 days. Emetine is no longer used. In some cases, one may add chloroquine 300 mg for 2 days, followed by 150 mg for 19 days.

In large abscess or when response to medical treatment is not satisfactory, drainage through wide-bore needle, or occasionally in complicated cases (rupture of abscess), surgical drainage is carried out.

A case of noncirrhotic portal fibrosis

1. **Prevalence** – Its incidence is high in India, accounting for 16–20% of patients with portal hypertension (3–5% worldwide).
2. **Etiology** – It occurs mostly in individuals with low socioeconomic status. The causes are
    - **a.** Infection – Bacterial infection of gut with recurrent septic embolization into the portal circulation.
    - **b.** Immunological – Alteration in T4/T8 lymphocyte ratio, hyper γ-globulinemia and granulocytopenia.
    - **c.** Familial predisposition.
    - **d.** Toxins (i) Arsenic ingested from high arsenic-containing drinking water, vegetables and ayurvedic drugs; (ii) vinyl chloride in India, (iii) some ayurvedic medicines and herbal toxins as the etiological cause in India cannot be ruled out.
3. **Clinical presentation**
    - **a.** Younger age (30–40 years)
    - **b.** GI bleed or splenomegaly (due to portal hypertension) seen in 90% of cases
    - **c.** Features of liver cell failure (e.g. ascites, jaundice and encephalopathy are uncommon).
    - **d.** Mild hepatomegaly in 50% of cases
    - **e.** Splenomegaly of varying size (mild to gross) in all
4. **Investigations**
    - **a.** CBC to assess severity of anemia (due to bleeding or hypersplenism).
    - **b.** LFT, usually normal or mildly deranged.
    - **c.** Endoscopy for varices – Esophageal, 90% and rectal (not piles), 70%.
    - **d.** Ultrasound shows normal liver architecture (intrahepatic portal veins are regular, unlike irregular and distorted vein distribution seen in liver cirrhosis).
    - **e.** Splenoportovenography demonstrates dilated splenic and portal veins, and dilated medium-sized portal venous channels (rarely done nowadays).
5. **Management**
    - **a.** Treatment of bleeding varices by vasopressin, somatostatin, octreotide infusion, sclerotherapy or Sengstaken–Blakemore tube balloon compression. Variceal band ligation is preferred for acute bleeding.

Viva voce

Q1. What is differential diagnosis of non cirrhotic portal fibrosis (NCPF)?

Tropical splenomegaly syndrome occurs in chronic malaria as an exaggerated immune response to malarial antigens, IgM (antibody) levels are high and there is no portal hypertension. Liver histology shows Kupffer cell hyperplasia with lymphocytes in liver sinusoids. Treatment is with antimalarials.

A case of hepatocellular carcinoma

1. **Introduction**
    - **a.** It is a common cancer worldwide but uncommon in India.
    - **b.** It is the commonest malignancy and an important cause of death in certain areas of Africa and South Asia.
2. **Etiology**
    - **a.** Sixty-five percent of cases have a background of cirrhosis of liver.
    - **b.** Chronic hepatitis B and C viral infection, alcoholic cirrhosis and hemochromatosis are predisposing causes.
    - **c.** Carcinogens (aflatoxins and nitrosamines) produced by *Aspergillus flavus* (a food-spoiling fungus) have been implicated.
3. **Clinical features**
    - **a.** It is asymptomatic for a variable period.
    - **b.** Pain in abdomen, or lump in right hypochondriac, epigastric region, loss of

appetite and loss of weight; low-grade fever is common.

- **c.** Unexplained deterioration of liver function in a stable patient with cirrhosis or intra-abdominal bleeding (from tumor).
- **d.** Presence of paraneoplastic syndromes such as Cushing's syndrome, hypercalcemia, hypoglycemia, polycythemia, hemolytic anemia, disseminated intravascular coagulation (DIC) and hyperlipidemia.
- **e.** Presence of friction rub or arterial bruit suggests the diagnosis in a known patient with cirrhosis of liver.

4. Investigations

- **a.** LFT – SGOT, SGPT, alkaline phosphatase and serum bilirubin are elevated (50–70%).
- **b.** Alpha fetoprotein and carcino embryonic antigen (CEA) are elevated.
- **c.** Ultrasonography – For extent of involvement (Fig. 2.30).
- **d.** CT scan/MRI for better delineation (Fig. 2.31). (Note – Figs. 2.30 and 2.31 are of different patients.)
- **e.** Hepatic angiography if surgery is planned.
- **f.** Ultrasound-guided liver biopsy to confirm the diagnosis.
- **g.** Laparoscopy for small tumors and biopsy.

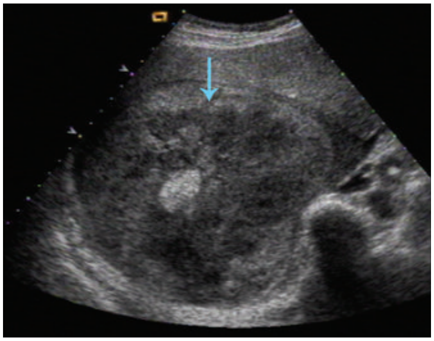


Figure 2.30 Ultrasonography showing HCC heterogenous appearance.

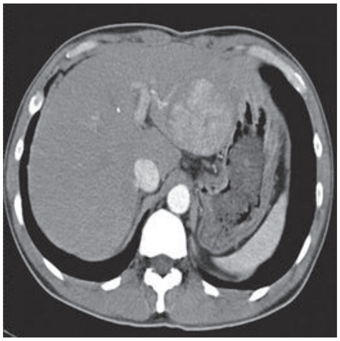


Figure 2.31 CT scan of abdomen showing HCC.

5. Management

- **a.** Surgical resection is possible in 10% of cases (if less than 5 cm in size and localized to one lobe of the liver).
- **b.** Coexistent cirrhosis, hepatitis B and C viral infection determine the prognosis (one-year survival around 80%, two-year survival less than 5%).
- **c.** Oral chemotherapy (sorafenib) used in inoperable disease.
- **d.** Hepatic artery chemoembolization, transtumoral ethanol injection and cryoablation used for palliation.
- **e.** Palliative radiotherapy for pain relief.
- **f.** Radiofrequency ablation for palliation of small lesions.
- **g.** Monoclonal antibody–targeted therapy is useful.
- **h.** Liver transplantation.

6. Preventive measures

- **a.** Prevention and treatment of hepatitis B and C infections
- **b.** Hepatitis B vaccination of children
- **c.** Prevention of contamination of food grains by aflatoxin (by improving grain storage)
- **d.** Periodic screening of HBV +ve patients by serum α-FP estimation and ultrasonography, for early diagnosis
- **e.** Treatment of hemochromatosis and alcoholism

A case of tuberculosis of abdomen

TB of abdomen presents clinically in three forms as intestinal, glandular and peritoneal tuberculosis. It may involve one or all the three structures. Prevalence has increased with HIV infection.

Intestinal tuberculosis

1. Etiopathology

- **a.** Ileocecal region is most commonly involved. Jejunum and colon are also involved.

  - **b.** Majority (two-third) are primary, i.e. without pulmonary tuberculosis.
  - **c.** Intestines are affected by hematogenous or lymphatic spread.
  - **d.** Intestinal ulcers occur due to tuberculous endarteritis in the submucous region; ulcers may heal completely with treatment. In some, there is fibrosis leading to stricture formation with subacute intestinal obstruction. In others, ulcers heal with hypertrophy of the mucosa at edges of the ulcer. Hence, sequelae of intestinal tuberculosis may result in ulcerative, hypertrophic or ulcerohypertrophic lesions. Typically, ulcers are transverse.

2. **Clinical presentation**
   - **a. Symptoms** – Pain in abdomen, loss of appetite, loss of weight, low-grade fever, gaseous distension, nausea, vomiting, more often diarrhea than constipation. Alternating diarrhea and constipation can be present. In later stage, patient may present with subacute intestinal obstruction (colicky pain, vomiting, distension, constipation). In women, amenorrhea may occur (due to endometrial tuberculosis).
   - **b. Signs**
     - **i.** Patient looks sick, febrile, emaciated with scaphoid abdomen.
     - **ii.** With intestinal obstruction, there is abdominal distension with visible peristalsis (step ladder pattern) (Fig. 2.15), and loud and increased intestinal sounds.
     - **iii.** Tenderness over abdomen, particularly in the ileocecal region with lumpy feeling. The feel of the abdomen is firm (doughy) due to peritoneal involvement.

Glandular tuberculosis

Abdominal glands may be enlarged as a part of generalized tuberculous lymph adenopathy or it may be a part of tuberculous abdomen involving intestines, peritoneum and glands.

Peritoneal tuberculosis

It may present as ascites (see case of ascites) or it may be a part of generalized tuberculous abdomen, involving intestines and glands with doughy feel of abdomen due to peritoneal involvement without ascites.

3. **Investigations**
   - **a.** Anemia with increased erythrocyte sedimentation rate (ESR).
   - **b.** Mantoux test is usually positive.
   - **c.** Chest X-ray may show pulmonary tuberculosis.
   - **d.** Plain X-ray of abdomen in standing position for fluid levels with suspected intestinal obstruction.
   - **e.** CT scan for ileocecal mass and lymphadenopathy.
   - **f.** Ultrasound of abdomen is less informative than CT scan.
   - **g.** Barium meal follow-through or small bowel enema may show ulcers and strictures with proximally dilated intestinal loops. There is narrowing of long segment of terminal ileum **(Stierlin's sign)** with thickening of ileocecal region and short ascending colon (Fig. 2.32).
   - **h.** Colonoscopy – Apart from looking for any lesion in colon and obtaining biopsy, one can visualize up to ileocecal region and take an ileal biopsy.
   - **i.** Peritoneoscopy/laparoscopy – To visualize intestines, mesentery and nodes, and performing biopsy.
4. **Diagnosis** – Differential diagnosis consists of Crohn's disease, ameboma, appendicular mass, actinomycosis of cecum, lymphoma and carcinoma of colon.

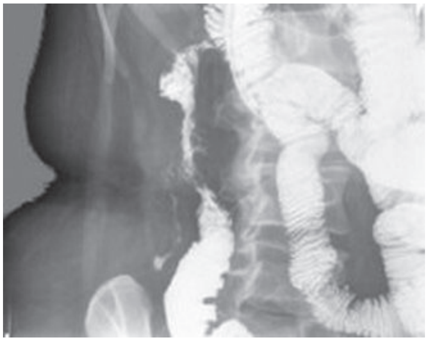


Figure 2.32 Ileocecal tuberculosis with narrowing of the terminal ileum, proximal dilatation, marked narrowing and contraction of cecum and ascending colon.

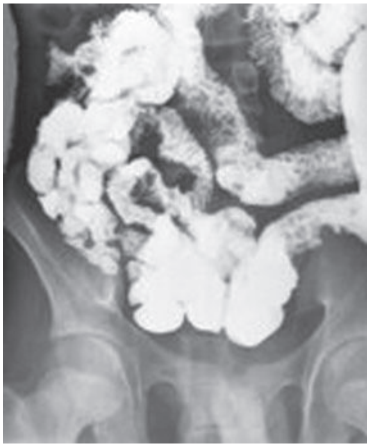


Figure 2.33 Crohn's disease of ileum producing multiple nodular cobblestone-like appearance, ulcerations and edema.

5. **Complications**
   - a. Intestinal obstruction
   - b. Perforation – peritonitis
   - c. Malabsorption syndrome, anemia, hypoproteinemia.

6. **Management**
   - a. Antituberculous treatment (standard regimen)
   - b. High-protein, high-calorie diet with vitamin supplements
   - c. Surgery for intestinal obstruction, perforation, massive hemorrhage.

Viva voce

Q1. What are the radiographic differences on barium meal follow-through between ileocecal tuberculosis and Crohn's disease?

In ileocecal tuberculosis, ulcers are transverse, whereas in Crohn's disease, these are longitudinal and transverse. In Crohn's disease, one can see thickened folds, aphthous ulcerations and edema. Multiple cobblestone like appearance is seen because of longitudinal and transverse ulcerations in the ileum (Fig. 2.33, compare it with Fig. 2.32 given above).

Chapter 3

Cardiovascular system

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EXAMINATION OF CARDIOVASCULAR SYSTEM

Evaluation of a patient with cardiovascular disease involves proper history taking, thorough clinical examination and obtaining results of investigations such as chest X-ray, electrocardiogram (ECG), pertinent biochemical and hematological laboratory tests. Special investigations such as 2D echocardiography, stress test, Holter monitoring, radionuclide tests, cardiac catheterization and coronary angiography are ordered wherever necessary.

Anatomy and physiology

Figure 3.1 shows chambers of heart and their communications. Figure 3.2 shows normal resting pressures in cardiac chambers.

History

The common symptoms are

1. **Chest pain** – The common cardiac causes of chest pain are
   - **a.** Angina pectoris (AP) due to coronary artery disease (CAD). Classical features of AP are retrosternal chest pain or heaviness with radiation across the chest with or without radiation to both the arms, shoulders or fingers but classically to left side; radiation to neck, jaw, and interscapular and epigastric regions occurs in some cases (Fig. 3.3). Pain has constricting or squeezing character. It is triggered by exertion, climbing stairs or walking uphill, emotional outburst such as anger and exposure to cold; angina of effort lasts for 1–5 minutes; angina due to emotional outburst lasts longer, up to 5–10 minutes. The pain is relieved by rest or by sublingual nitrates. This is typical stable angina as against unstable angina which occurs at rest without obvious trigger factors and lasts for several minutes. It is in fact an acute coronary syndrome and if not treated can progress to acute myocardial infarction (AMI). The characteristics of chest pain in an AMI are same but severity is more; pain lasts longer and is accompanied by sweating, palpitation, breathlessness and sometimes cardiogenic shock (Box 3.1).

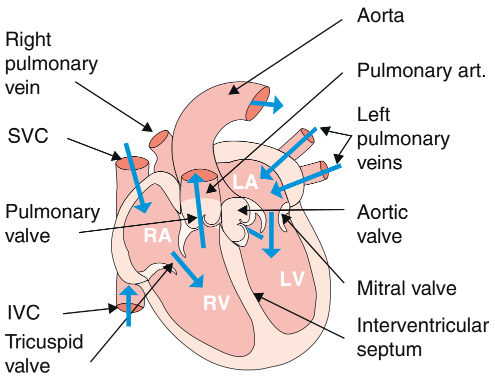

Aorta
Right pulmonary vein
Pulmonary art.
SVC
Left pulmonary veins
LA
Pulmonary valve
RA
Aortic valve
LV
Mitral valve
RV
IVC
Interventricular septum
Tricuspid valve

Figure 3.1 Schematic diagram showing chambers of heart and their communications.

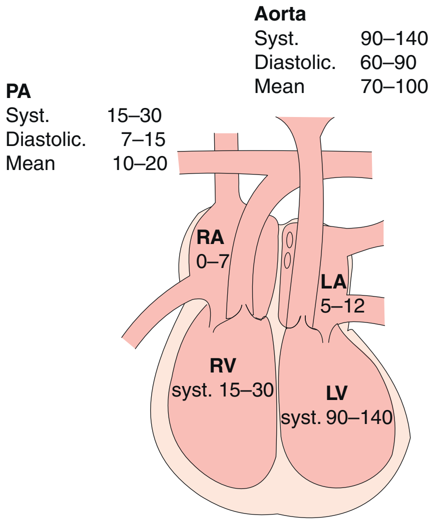

Aorta
Syst. 90–140
Diastolic. 60–90
Mean 70–100
PA
Syst. 15–30
Diastolic. 7–15
Mean 10–20
RA
0–7
LA
5–12
RV
syst. 15–30
LV
syst. 90–140

Figure 3.2 Normal resting pressures in cardiac chambers (mm of mercury).

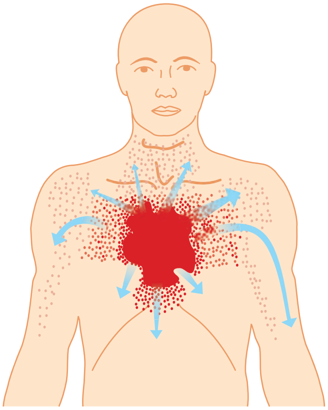


Figure 3.3 Angina pectoris and acute myocardial infarction. Central and retrosternal chest pain with radiation to arms, jaw and epigastric region.

   - **b.** Chest pain due to acute pericarditis – It is localized to midprecordial area, is constant and not related to exertion or emotion. It is aggravated by deep inspiration, cough or change in posture (e.g. turning in bed). Pain is stabbing, burning or cutting in character. It lasts for hours or days, and it is not relieved by nitrates. Pleuropericarditis pain is relieved by breath holding.
   - **c.** Chest pain due to aortic dissection – It is of sudden onset and very severe involving the front or back of chest; pain may radiate down the spine if the aortic dissection extends down the aorta. It may be mistaken for AMI, but the ECG changes of AMI are absent.

Differences between AP and AMI — Box 3.1

Character	AP	AMI
Site	Retrosternal	Retrosternal
Precipitating factors	Exertion/ emotions	Exertion, emotion but not always; can occur at rest or during sleep
Severity	Mild to moderate	Very severe (crushing)
Effect of rest	Relief	No effect
Nausea and vomiting	None	Usually present
Sympathetic activity	Absent	Present (significant)
Anxiety and restlessness	+	+++
Fall in blood pressure, cardiogenic shock	Absent	++ (common)
Cardiac enzymes and troponin	Normal	Elevated

d. In severe mitral stenosis (MS) with left atrial dilatation, there may be chest pain and discomfort in the back along with dysphagia (due to compression of esophagus).
e. Aneurysm of ascending aorta (AA) or arch of aorta can cause chest discomfort due to compression.
f. Acute pulmonary embolism causes angina of right ventricle (RV) with chest pain.
g. Esophageal spasm causing retrosternal chest pain needs to be differentiated from AP (Box 3.2).
h. Other causes of chest pain are – myalgia, costochondritis, severe anxiety, panic attacks and hyperventilation.

2. **Dyspnea** – It is a presenting symptom of acute left ventricular failure (LVF). There is congestion of pulmonary veins and capillaries causing fluid collection in interstitial tissue and alveolar edema. The lungs become rigid and the increased work of breathing causes breathlessness. Other cardiac causes of dyspnea are acute pulmonary embolism, pulmonary infarction and severe pulmonary hypertension (PHT).

Differences between AP and esophageal spasm — Box 3.2

Character	AP	Esophageal spasm
Site	Retrosternal and spreading across front of chest and rarely to epigastric region	Retrosternal and spreading to epigastric region
Radiation	Across chest, both arms (left more than right, jaw)	Epigastrium, back
Precipitating factors	Exertion, emotion	Spicy, hot food and drinks (tea, coffee)
Relieving factors	Rest, sublingual sorbitrate	Not relieved by rest, may be relieved by sorbitrate
Duration	2–10 minutes	Variable

According to New York Heart Association (NYHA), dyspnea is graded into four grades:

Grade I – No dyspnea on daily routine work
Grade II – Dyspnea on daily routine work
Grade III – Dyspnea on less than daily routine work
Grade IV – Dyspnea at rest

Dyspnea can be

a. **Exertional** – e.g. climbing stairs, exercise
b. **Paroxysmal nocturnal** – It develops during sleep, patient wakes up from sleep with breathlessness (air hunger), sits up and seeks fresh air (opens windows).
c. **Orthopnea** – Here dyspnea develops soon after lying flat and is relieved on sitting up. Lying flat increases venous return and causes steep rise in left atrial pressure in patients with heart failure resulting in pulmonary congestion. In advanced cases, patients prefer to sleep in sitting position (90° backrest) or even with head resting on a bed table or an armrest.
d. **Acute pulmonary edema (due to acute LVF)** – Dyspnea is sudden in onset and is accompanied by cough with white or pink frothy sputum, tachycardia, sweating and cyanosis.

3. **Cough (usually dry, irritating and worse at night)** – It is a symptom of pulmonary congestion and often accompanies dyspnea. It may be triggered by exertion.
4. **Palpitation** – It is defined as unpleasant awareness of one's heartbeat due to altered rate, rhythm or force of contraction. Usual cause is sinus tachycardia or sinus arrhythmia. Sudden attacks of palpitation suggest paroxysmal supraventricular or ventricular tachycardia. Sometimes, palpitation is due to enlarged, hyperdynamic left ventricular pulsations (mitral or aortic regurgitation [AR]). Extrasystoles felt as intermittent skips are another common cause of palpitations as are anxiety and cardiac neurosis.
5. **Edema (due to chronic venous insufficiency)** – It is seen around ankles and feet. There is progressive swelling of legs during the day and on recumbent posture it reduces. Edema may be localized or generalized. Localized edema is due to lymphatic or venous obstruction. Generalized edema can be due to cardiac, hepatic and renal diseases, severe anemia, hypoproteinemia and beriberi. In cardiac disease, edema appears first in dependent parts i.e. over feet. With increasing severity, edema may spread to legs, and ascites may develop. In bedridden patients, edema is present over sacral region. (For causes of pitting edema, see Chapter 1, page 22.)

   In renal disease, edema first develops over lower eyelids, most marked when patient wakes up in the morning. In liver cirrhosis, fluid first collects in abdomen (ascites) and later edema appears over the legs. In myxedema, there is generalized nonpitting edema while in filariasis, edema is localized and nonpitting.
6. **Pain in right hypochondrium and epigastric region (liver area)** – In congestive heart failure, liver is enlarged, congested and tender. Pain may be aggravated after meals due to increased splanchnic blood flow.
7. **Nausea** – Loss of appetite due to congestion of stomach.
8. **Oliguria** – In congestive cardiac failure (CCF) patient passes less urine during the day (oliguria). During sleep, redistribution of fluid leads to better renal perfusion and patient develops nocturia (passing urine more than once at night), with the result that edema is less in the morning.

Cardiovascular causes of syncope **Box 3.3**

- All stenotic lesions, particularly AS and MS
- Arrhythmias (paroxysmal supraventricular and ventricular arrhythmias, complete heart block)
- Hypertrophic obstructive cardiomyopathy (HOCM)
- Postural hypotension (orthostatic hypotension)
- Atrial myxoma, ball-valve thrombus
- Severe PHT
- Subclavian steal syndrome

9. **Fatigability** – It is due to poor blood supply to muscles in low cardiac output states such as mitral stenosis (MS), aortic stenosis (AS), pulmonary stenosis, tricuspid stenosis (TS) and CCF.
10. **Fainting (syncope) or dizziness** – With low cardiac output states, cerebral perfusion is impaired and patient may suffer from fainting spells (Box 3.3).
11. **Cardiac cachexia** – It is due to poor blood supply to tissues, and tumor necrosis factor-α which increases catabolism in chronic CCF.
12. **Squatting** – Cyanotic children with Fallot's tetralogy assume squatting position which increases arterial resistance, thus diverting a greater volume of blood to the pulmonary circulation with better oxygenation and relief of anoxic spells.
13. **Stokes–Adams attacks** – These are due to either asystole (complete heart block) or rapid tachyarrhythmias including ventricular fibrillation. As there is no cardiac output during this period, cerebral perfusion suffers causing syncope. Patient develops pallor, sweating and passes off. With restoration of sinus rhythm, the patient regains consciousness and pallor disappears.

Physical examination

General examination

Built and development – Patients with congenital or valvular heart disease acquired in early childhood may be short statured and underdeveloped (exclude family history of short stature). In heart failure, patient is breathless. Look for pallor, cyanosis and clubbing. Pallor is a feature of infective endocarditis (IE). Severe anemia may cause heart failure. Differentiation between peripheral and central cyanosis is given in Table 1.2. For causes of clubbing and for grades of clubbing, see Box 1.15 and Fig. 1.32, respectively. Icterus is seen sometimes in chronic CCF or constrictive pericarditis due to liver congestion. In pulmonary infarction, icterus is present due to lysis of red blood cells (RBC).

Face may be puffy in patients with constrictive pericarditis and mediastinal compression syndrome. Neck veins are engorged and pulsatile in congestive heart failure and nonpulsatile in patients with constrictive pericarditis and mediastinal compression. Prominent arterial pulsations (carotids) are seen in aortic incompetence (AI) and patent ductus arteriosus (PDA); pulsations in suprasternal notch suggest aortic arch aneurysm, other causes are high aortic arch and right subclavian artery originating from left side.

Over the chest, look for pectus excavatum, precordial bulging, visible cardiac impulse, visible arterial pulsations in right (aortic) and left (pulmonary) second spaces and parasternal regions on right (right atrial pulsations) and left sides (right ventricular pulsations). Engorged veins over chest indicate superior or inferior vena caval obstruction.

There is distension of abdomen due to ascites in CCF. Look for scrotal, sacral edema and edema over feet. In addition, look for the following features as these give a clue to the diagnosis.

- Hypertelorism – Tricuspid atresia
- Mongoloid features – Atrial septal defect (ASD)
- Mitral facies – MS
- Ear lobe crease – CAD (see Fig. 1.17)
- Arachnodactyly – Seen in Marfan's syndrome which may be associated with AR, aortic dissection, mitral valve prolapse (MVP) and conduction abnormalities. Other features like high arched palate, ectopic lens and arm span more than height (see Fig. 1.9) may be present
- Rheumatic nodules – Acute rheumatic fever, usually associated with carditis, rheumatic valvular heart disease
- Osler's nodes, Janeway lesions (see Fig. 9.44), splinter hemorrhages and nail-fold lesions due to infarcts (see Fig. 9.45) in nails. These are cutaneous manifestations of infective endocarditis.
- Rheumatoid nodules (see Fig. 9.21) and rheumatoid abnormalities of hands; look for aortic regurgitation
- Xanthomas, xanthelasmas (Fig. 3.4) and premature arcus senilis (Fig. 3.5) indicate hypercholesterolemia

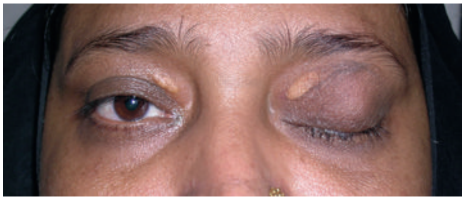


Figure 3.4 Xanthelasmas over both upper eyelids, and ptosis on left side.

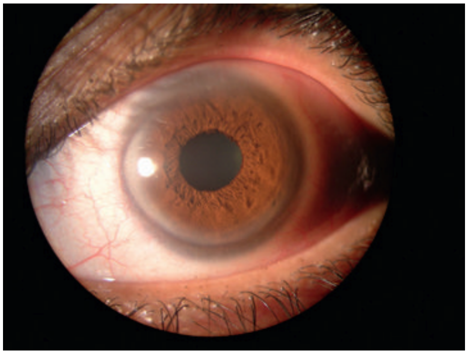


Figure 3.5 Arcus senilis.

- Look for deep venous thrombosis – Swelling, redness, warmth, tenderness over calf muscles in a suspected case of pulmonary embolism
- Thyromegaly – Look for thyroid heart disease
- Cold and clammy hands and feet in severe heart failure and cardiogenic shock
- Fever – An important feature of IE. In AMI, patient may have pyrexia for the first few days, and in acute rheumatic fever or recrudescence of rheumatic fever in documented valvular heart disease, fever is a presenting feature

Pulse

Place three fingers (index, middle and ring) on the radial artery at the wrist and note rate, rhythm, volume, character and condition of the arterial wall.

1. **Rate** – Count the pulse rate for at least 1 minute. The normal rate in adult varies from 60–90 beats/minute. Heart rate above 90 beats/minute is sinus tachycardia (Box 3.4) and below 60 beats/minute is sinus bradycardia (Box 3.5).
2. **Rhythm** – In healthy person, normal sinus rhythm is regular; in some young persons, one may appreciate sinus arrhythmia (rate increasing with inspiration and slowing with

Causes of sinus tachycardia (more than 90 beats/minute) Box 3.4

- Exercise, stress, anxiety, emotional excitement, excess of caffeine (tea and coffee), alcohol and smoking
- Pyrexia
- Pain
- Hyperthyroidism
- Heart failure, AMI, acute pulmonary embolism
- Medications – sympathomimetics, vasodilators
- Pheochromocytoma

Causes of sinus bradycardia (40–60/min) Box 3.5

- Physiological-athletes, vagotonic individuals, sleep, sedation
- Myxedema
- Increased intracranial pressure
- Drugs (beta blockers, Verapamil, diltiazem, digoxin)
- Obstructive jaundice
- Organophosphorus, aluminium phosphide poisoning, scorpion bite
- II and III degree heart blocks

expiration) (Fig. 3.6). An irregular pulse may be regularly irregular (e.g. unifocal ectopic beats appearing at fixed intervals followed by a pause) and irregularly irregular (e.g. multifocal, multiple ectopics occurring haphazardly or atrial fibrillation [AF]). In AF, there is pulse apex deficit of more than 10 beats/minute (detected by simultaneous counting of pulse and heart rates by auscultation), as some weak heartbeats are not transmitted to the radial artery. Pulse deficit also can be present in multiple, multifocal extrasystoles. With exercise, pulse may become regular in extrasystoles, but there is no effect in AF. In fact, it may worsen. See Box 3.6 for causes of irregular pulse and Box 3.7 for causes of AF.

3. **Volume** – It is judged by the uplift perceived by the palpating finger. Pulse volume varies with pulse pressure and is described as high, normal, small or poor volume pulse.

Causes of irregular pulse Box 3.6

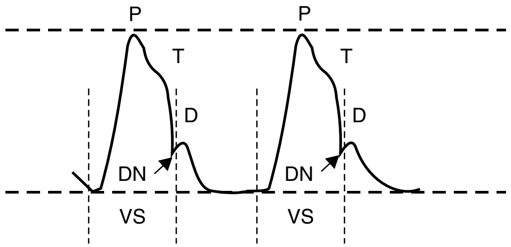
- Sinus arrhythmia
- Extrasystoles (atrial, nodal, ventricular)
- Atrial fibrillation
- Atrial flutter with variable ventricular response
- Second-degree heart block with variable response (dropped beats)

Causes of AF Box 3.7

- Mitral stenosis
- Hyperthyroidism
- Ischemic heart disease (IHD)
- Congestive cardiac failure
- Myocarditis
- Hypertension (HT)
- Cardiomyopathy (CMP)
- Following cardiothoracic surgery
- Drugs (digitalis toxicity)
- Poisoning – Yellow oleander poisoning

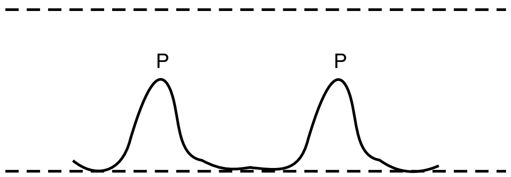
a. **High volume pulse (water hammer, collapsing or Corrigan's pulse)** – High volume pulse described by Corrigan is better felt with palm of right hand kept over the radial artery and palm of left hand over brachial artery when the patient's arm is raised above heart level. It is called *water hammer* because percussion wave of radial pulse gives a water-hammer-like feeling to palpating hand. It is called *collapsing* because the pulse disappears fast from palpating hand (downward slope of the pulse wave) (Fig. 3.6). Since Corrigan described it, it is also called *Corrigan's pulse*. For causes of collapsing pulse, see Box 3.8.

b. **Low volume pulse** – Here pulse pressure is less due to either fall in systolic blood pressure (SBP) (low cardiac output states) or rise in diastolic blood pressure (DBP) (due to increased peripheral resistance), or both. All stenotic lesions (mitral, aortic, tricuspid, pulmonary) cause low volume pulse. In MS, pulse is low volume but ill sustained (pulsus parvus), but in AS, it is i.


P
P
T
T
D
D
DN
DN
VS
VS

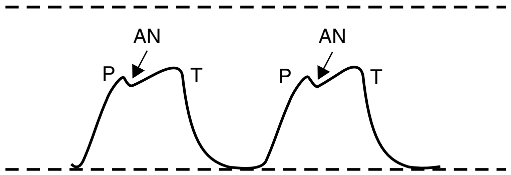
Normal pulse waves
P - percussion wave; T - tidal wave; D - dicrotic wave; DN - dicrotic notch; VS - ventricular systole

ii.



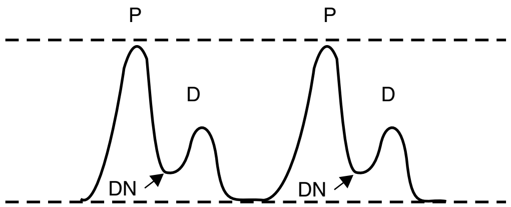
Pulsus parvus (MS)

iii.



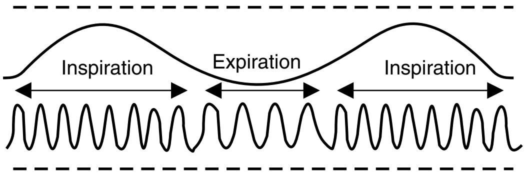
Anacrotic pulse (AN - anacrotic notch) (AS)

iv.

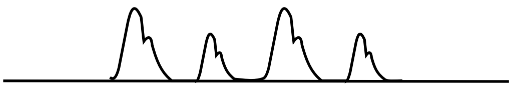


Dicrotic pulse (prominent dicrotic wave e.g. fevers)

v.

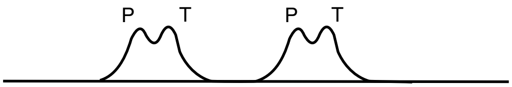

Inspiration
Expiration
Inspiration

Sinus arrhythmia (pulse rate increases during inspiration and slows during expiration)



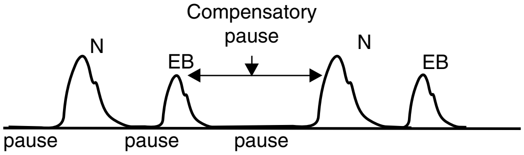
Pulsus alternans. Regular sinus rhythm. Alternating beats strong and weak (LVF)

Pulsus alternans



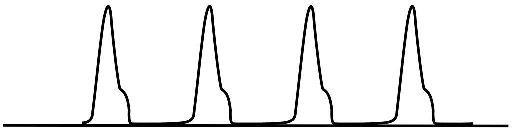
Pulsus bisferiens, best detected by palpation of the carotid artery. Has two main peaks of percussion wave (P) and tidal wave (T) (combined AS & AI)

Pulsus bisferiens


Compensatory pause
N
EB
N
EB
pause
pause
pause

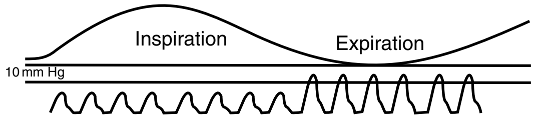
Bigeminal pulse due to alternating extrasystole (EB). The amplitude of the premature beat is less than that of the normal beat and is followed by a compensatory pause (e.g. digitalis toxicity)

Pulsus bigeminus



Water-hammer pulse (collapsing pulse) has a rapid rise, a narrow summit, and a sudden descent (patent ductus arteriosus, aortic regurgitation)

Water-hammer pulse (Corrigan's pulse)


Inspiration
Expiration
10 mm Hg

Pulsus paradoxus - There is an exaggerated decrease (>10 mm Hg) in the amplitude of pulsation during inspiration and increased amplitude during expiration. (Pericardial effusion, constrictive pericarditis, bronchial asthma, emphysema.)

Pulsus paradoxus

Figure 3.6 Types of pulses.

Causes of collapsing pulse Box 3.8

Cardiac

- Aortic regurgitation
- Severe mitral incompetence
- Large ventricular septal defect (VSD)
- Patent ductus arteriosus
- Complete heart block

Systemic

- Hyperthyroidism
- Severe anemia
- Beriberi
- Paget's disease of bone
- Fever

Physiological

- Hot bath
- Pregnancy

Causes of low volume pulse Box 3.9

- Mitral stenosis (pulsus parvus) (Fig. 3.6)
- Aortic stenosis (pulsus parvus et tardus) (Fig. 3.6)
- Tricuspid stenosis
- Pulmonary stenosis
- Pulmonary hypertension
- Cardiogenic shock

In peripheral vascular diseases, pulsations of affected vessels may be of low volume.

low volume and well sustained (pulsus parvus et tardus) (Fig. 3.6). For causes of low volume pulse, see Box 3.9.

c. **Varying volume pulse**

   i. **Pulsus paradoxus (Fig. 3.6)** – The term *paradoxus* is a misnomer. There is in fact an exaggeration of the normal phenomenon of low volume pulse during inspiration and better volume pulse during expiration (normal fall of SBP less than 10 mm Hg). In pulsus paradoxus, this is exaggerated and fall of SBP is greater than 20 mm Hg during inspiration. Fall between 10 and 20 mm Hg is borderline and not clearly diagnostic. The causes of pulsus paradoxus are (i) constrictive pericarditis and massive pericardial effusion which restrict diastolic filling of right atrium and RV during inspiration and thus lower left ventricular stroke volume, resulting in fall of SBP. During expiration, hemodynamics reverse which improves SBP; (ii) severe bronchial asthma, the increased negative intrathoracic pressure during inspiration leads to pooling of blood in pulmonary veins, which lowers pulmonary venous return.

   ii. **Pulsus alternans** – It is a regular pulse, but alternating beats are strong and weak, seen in advanced LVF. It is very difficult to appreciate strong and weak beats by palpation as difference in the volumes of pulses is very small. For example, stronger beats may have BP 120/80 mm Hg, and weaker beats may have BP 110/80 mm Hg; this is best appreciated while recording BP. As the mercury column is being lowered, in the above example at 120 level, half the beats (strong) are audible, but when mercury level touches 110, the other weaker beats also become audible with sudden doubling in the number of audible beats. This phenomenon of doubling of audible beats while measuring BP confirms pulsus alternans (Fig. 3.6).

4. **Character of pulse** – There are some characteristic types of pulses which help in the diagnosis of underlying conditions (Fig. 3.6).

   a. **Water hammer or collapsing pulse (described above)** – Water hammer character of pulse is coined after the French toy of glass tube half filled with water and hermetically sealed. When you turn the tube upside down in your palm, you get water hammer thud feeling (Fig. 3.7).

   b. **Anacrotic pulse** – Low volume, well sustained

   c. **Pulsus parvus** – Low volume, ill sustained

   d. **Pulsus bisferiens (double-peaked pulse)** – Here two peaks of almost the same amplitude are felt during each systole, the first peak is due to percussion wave and the second peak is due to a delayed tidal wave. It is classically present in combined AS and AR (Fig. 3.6).

   e. **Pulsus bigeminus** (see Chapter 10, Quiz 10) – The pulse is regularly irregular due to fixed unifocal ectopics following every normal beat followed by a compensatory

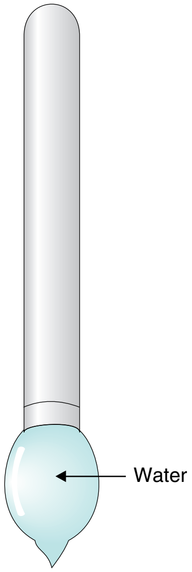


Figure 3.7 Water hammer (a French toy).

pause. If ectopics appear after two normal beats, it is called *trigeminus* pulse (see Chapter 10, Quiz 11), and if it is felt after three normal beats, it is termed *quadrigeminus pulse*.

f. Dicrotic pulse – It is seen in high-grade fevers when dicrotic wave is accentuated. Two impulses are felt with each beat. One during systole due to percussion wave and the second (of lower amplitude) during diastole due to exaggerated dicrotic wave (Fig. 3.6).

5. **Condition of the arterial wall** – The arterial wall is felt by rolling the radial artery with fingers against the underlying bone. It feels soft and elastic in young age, and with aging, thickened arterial wall is appreciated. Locomotor brachial seen in arm as a sinusoidal arterial pulse wave is due to arteriosclerosis (loss of elasticity of artery). It is not to be confused with atherosclerosis where tortuosity is not a feature. In giant cell arteritis, one can feel thickened, tender and nodular superficial temporal arteries (see Fig. 9.8).
6. **Palpation of other arteries** – After detailed examination of radial artery, one should palpate opposite side radial and bilateral brachials, carotids, femorals, popliteals, posterior tibials and dorsalis pedis. Unequal radial arteries (right better volume than left) indicate presubclavian coarctation of aorta. Delayed and weaker femoral artery pulsation in comparison to radial indicates coarctation of aorta. In Takayasu's disease with predominant abdominal aortic involvement, femoral pulsations are weaker. Same finding is present with saddle embolus at the bifurcation of abdominal aorta. Similarly, weaker carotid pulse or peripheral arterial pulses indicate atheromatous plaques in the arteries. Aortic arch aneurysm and aortic dissection are other causes of unequal upper limb pulses. Takayasu's disease with only aortic arch involvement results in femorals being felt better than radials (reversed coarctation). Radial artery may not be felt after coronary artery bypass graft (CABG) with radial artery graft. When a peripheral artery is not felt, always palpate proximal vessels to locate the site of block. A thrill or bruit is often present at the site of narrowing. Inability to feel one side dorsalis pedis can be a normal anatomical variation (see Box 3.10 for causes of unequal pulses).

Causes of unequal pulses **Box 3.10**

- Coarctation of aorta
- Aortic aneurysm (arch, abdominal)
- Takayasu's arteritis
- Buerger's disease
- Aortic dissection
- Post-CABG with radial artery graft
- Peripheral vascular disease
- Peripheral embolism
- Blalock–Taussig shunt
- Thoracic outlet syndrome

Jugular venous pressure

Observe neck for pulsations and prominence of jugular veins. These should be differentiated from carotid artery pulsations (Table 3.1). For measurement of jugular venous pressure (JVP), patient should have either backrest or pillows so as to be in 45° propped up position with reference to the flat of bed. To measure JVP, the upper level of pulsations in internal jugular vein is identified, and a scale is held parallel to the bed from that point. A second scale measures the vertical distance between angle of Louis and the scale held parallel to the bed. This value is the JVP. Normally, it is 0–4 cm (Fig. 3.8). In CCF, JVP is raised and veins are pulsatile, whereas in superior vena cava (SVC) obstruction, jugular veins are engorged but nonpulsatile. When JVP is very high and upper level is not visible, the patient is examined in sitting

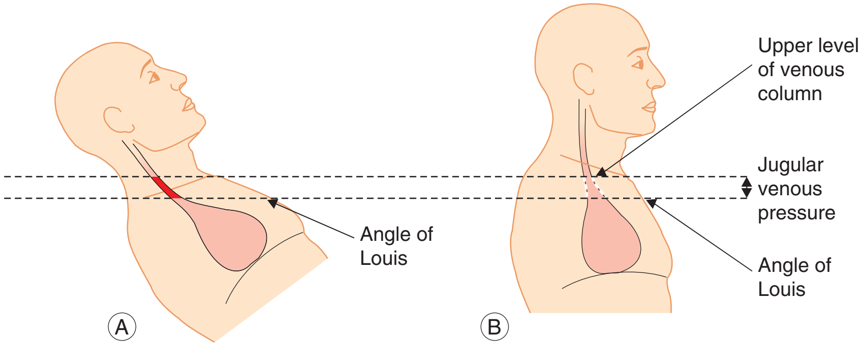


Figure 3.8 Jugular venous pressure in a normal person. (A) At 45°, point of transition between distended and collapsed veins is seen to pulsate just above clavicle. (B) At 90° upright position, upper part of vein collapsed. Column not seen. Note – The pressure measured is same at 45° elevation and upright position.

posture. With very high JVP, one can see pulsations of ear lobule in cases of tricuspid regurgitation (TR).

Table 3.1 Differences between venous and arterial pulsations in the neck

Venous (jugular) pulsations	Arterial (carotid) pulsations
Not palpable	Palpable
Characterized by rapid inward movement with two peaks per heart beat	Characterized by rapid outward movement with one peak per heart beat
Can be obliterated by finger pressure at the root of neck	Cannot be obliterated with pressure at the root of neck
Has two peaks (systolic and diastolic) at upper level of venous column	Has single systolic peak all along the artery
Varies with breathing	No change with breathing
Varies with the position of patient	Does not vary with position of the patient
Hepatojugular reflux positive by pressure over right hypochondriac region or abdomen (Fig. 3.9) (exception Budd–Chiari syndrome)	Hepatojugular reflux absent

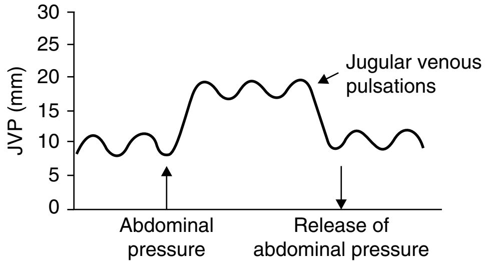


Figure 3.9 Positive hepatojugular reflux, *paripassu* with abdominal compression; blood column remains elevated until abdominal pressure is released. Positive in TS and right ventricular failure.

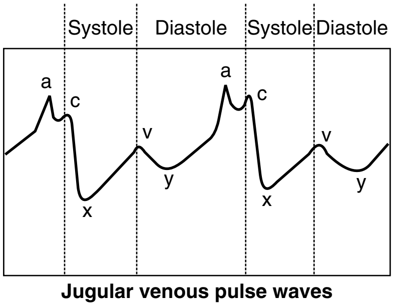


Figure 3.10 Jugular venous pulse waves: a – atrial systole, c – due to ballooning of tricuspid valve in right atrium during onset of ventricular systole, x – trough due to atrial relaxation, v – due to venous filling of right atrium during ventricular systole, y – descent due to emptying of right atrium.

Normal venous pulsations

One can observe three positive waves in jugular veins (a, c, v) (Fig. 3.10). These reflect pressure changes in right atrium. The 'a' wave is caused by atrial systole. The 'c' wave occurs during ventricular systole and is due to ballooning of tricuspid valve in the right atrium. The 'a' and 'c' waves are invariably fused to form 'ac' complex. Following the 'c' wave, there is 'x' trough which is due to atrial relaxation. The 'v' wave follows 'x' descent and is due to venous filling of the right atrium during ventricular systole. Following the 'v' wave, there is a trough termed as *y descent*, which is due to emptying of the right atrium into the RV. In AF, 'a' wave and 'x' descent are absent. The ‘a’ waves are prominent (giant) in PHT, pulmonary stenosis, TS and Ebstein’s anomaly. In complete heart block, when atrial and ventricular systoles occur simultaneously, very prominent ‘a’ waves called *cannon waves* are seen when the right atrium contracts against closed tricuspid valve. The ‘v’ wave is exaggerated in TR, heart failure and constrictive pericarditis (Fig. 3.11).

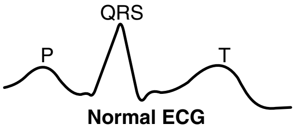
During inspiration, pressure within the chest falls and there is fall in the JVP. However, in constrictive pericarditis, increased venous return during inspiration cannot be accommodated within the constricted right side of the heart; with a paradoxical rise in JVP (Kussmaul’s sign). See Box 3.11 for causes of raised JVP and Box 3.12 for important abnormalities of jugular venous pulse.

Causes of raised JVP **Box 3.11**

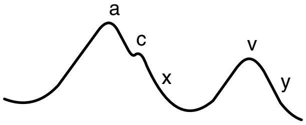
- Congestive cardiac failure
- Cor pulmonale (acute, chronic) with right heart failure
- Pericardial effusion, constrictive pericarditis
- Right ventricular infarction
- Restrictive CMP
- Superior vena cava obstruction (mediastinal compression syndrome)
- Thrombosis of SVC
- Unilateral nonpulsatile raised JVP suggests obstruction at the root of the neck

Important abnormalities of JVP **Box 3.12**

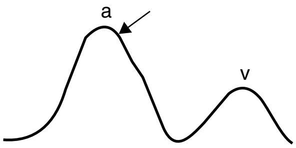
Heart failure	Raised, pulsatile, positive hepatojugular reflux
Superior vena cava obstruction	Raised but nonpulsatile
Pericarditis with effusion	Raised, with prominent ‘y’ descent
Constrictive pericarditis	Raised, Kussmaul’s sign present
Atrial fibrillation	Absent ‘a’ waves
Tricuspid stenosis	Giant ‘a’ waves
Tricuspid regurgitation	Giant ‘v’ waves
Complete heart block	Cannon waves
Budd–Chiari syndrome	Absent hepatojugular reflux



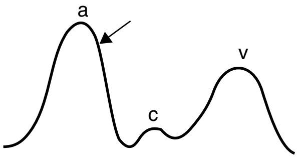
Normal ECG



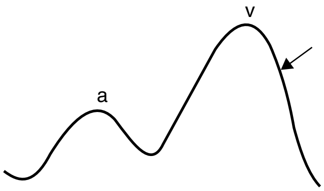
Normal jugular vein waves
P and QRS complex (electrical events in ECG) precede ‘a’ and ‘v’ waves (mechanical events in JVP)



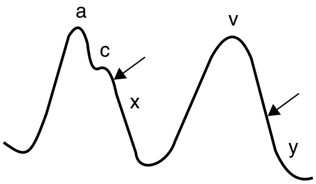
Giant ‘a’ wave - result from forceful atrial systole against narrow tricuspid valve (TS) (seen with each cardiac cycle)



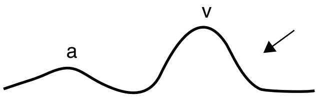
Cannon ‘a’ wave - result from atrial contraction against a closed tricuspid valve (seen in complete heart block due to simultaneous atrial and ventricular systole (seen intermittently)



Giant ‘v’ waves seen in tricuspid regurgitation (Regurgitant jet producing prominent systolic waves in neck veins)



Steep ‘x’ and ‘y’ descents are seen in constrictive pericarditis.



Absent ‘a’ wave in atrial fibrillation

Figure 3.11 Abnormalities of jugular venous pulsations.

Sternal angle or angle of Louis – It is an important landmark. It corresponds to second costal cartilage joining sternum at manubriosternal junction. It corresponds to the upper border of right atrium.

Precordium – It is the part of chest that overlies the heart. Before one starts with examination, one should know important vertical planes (lines) and anatomical landmarks used in practice to describe cardiac findings.

Vertical planes of the chest wall (Fig. 3.12)

• Midsternal plane	Passes through midline of sternum
• Lateral sternal planes	Pass along lateral sternal borders
• Midclavicular planes	Midclavicle down on both sides, roughly correspond to nipple line in young men
• Parasternal planes	Midway between lateral sternal and midclavicular planes
• Anterior, mid and posterior axillary planes	Pass along anterior, mid and posterior axillary lines
• Midscapular plane	Passes through inferior angle of scapula
• Vertebral plane	Passes through spinous processes

Examination of precordial region

Inspection

1. **Shape of precordium** – (Note for any deformity of thorax and spine. These can alter the position of apical impulse.) In long-standing cases of enlarged heart or pericardial effusion, there may be generalized precordial prominence. Other abnormalities to be noted are pectus excavatum (saucer- or funnel-shaped chest), pigeon-shaped chest and rickety rosary (due to old rickets). Shape of precordium may be affected by chest deformities (see Chapter 4, pg. 116). Marked chest deformity can displace apical impulse and cause auscultatory abnormalities (murmurs). Cardiac pathologies (chamber enlargement/hypertrophy) as seen in congenital heart diseases or childhood-acquired valvular disease can produce localized precordial bulge. Generalized precordial prominence is seen in long-standing enlarged heart or pericardial effusion.

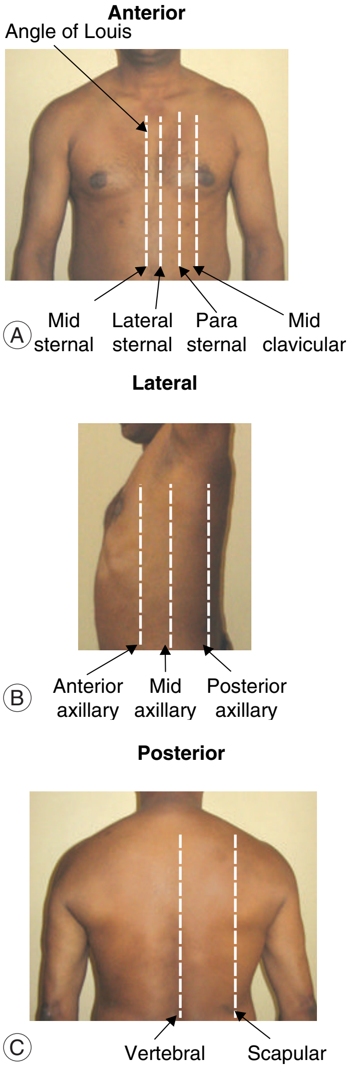


Figure 3.12 Vertical planes (chest).

2. **Pulsations** – Note pulsations over the precordial region. First identify the cardiac impulse (apex impulse) which in persons with thin chest wall is visible in the 5th intercostal space (ICS) just inside left midclavicular line. Normal apex impulse is not visible in persons with obesity, emphysema, or pericardial effusion or if apex is lying behind the rib. If apex impulse is not visible on the left side, exclude dextrocardia (Fig. 3.13).

Right ventricular pulsations are seen in left parasternal plane in 3rd, 4th and 5th ICSs and sometimes in the epigastric region. Pulmonary

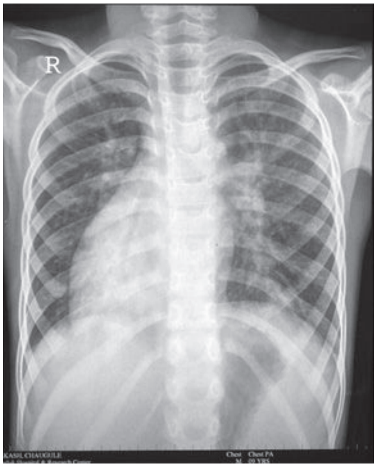


Figure 3.13 Dextrocardia.

artery pulsations may be noticeable in left 2nd ICS just lateral-to-lateral sternal plane. Aortic pulsations may be seen in suprasternal notch or right 2nd ICS lateral-to-lateral sternal plane.

Look for dilated veins over chest wall. These may be present in SVC obstruction (flow from above downwards) or inferior vena cava obstruction (flow from below upwards).

Next look for pulsations –

- **a.** In suprasternal area (AI, aortic aneurysm, coarctation of aorta, aberrant origin of right subclavian artery from left side, abnormal thyroidea ima artery);
- **b.** In neck (hyperkinetic state, hyperthyroidism, AR, carotid or subclavian artery aneurysm);
- **c.** In epigastric region (right ventricular hypertrophy [RVH], liver pulsations, aneurysm of abdominal aorta, aortic pulsations in a thin person, tumor lying anterior to the aorta) and
- **d.** At the back (dilated intercostal arteries [Suzman's sign] in coarctation of aorta). Prominent abnormal site/ectopic pulsations over precordium are seen in left ventricular aneurysm (Fig. 3.14), CMP or left ventricular dysfunction.

Palpation

Place your right hand (after warming in cold weather) over precordial region and try to localize the apex beat with the tip of the middle finger. It is the outermost and lowermost point of maximum cardiac impulse felt by palpating finger kept perpendicular to the chest wall. Normally, apex impulse is located in 5th ICS 1 cm inside the left midclavicular line. Ascertain the character of apex beat (tapping, forcible/hyperdynamic or heaving and sustained), feel for thrills with the palm of hand. Turning the patient to left lateral position helps to appreciate better character of apex beat and thrills. Giving exercise and then palpating in left lateral position often brings out diastolic thrill of MS better (not done when patient is in failure). For aortic and pulmonary thrills, patient is examined in sitting position, bending forward and in expiratory apnea.

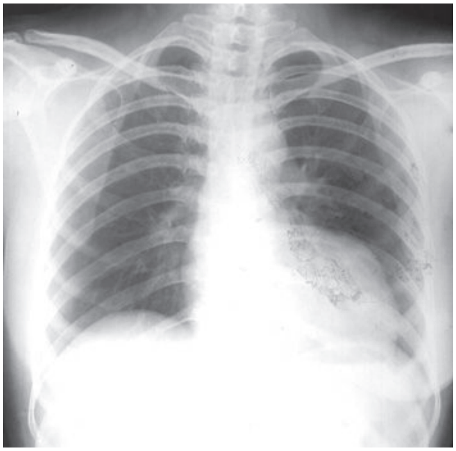


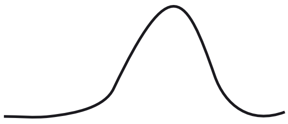
Figure 3.14 Left ventricular aneurysm.

Types of apex beat (Fig. 3.15)

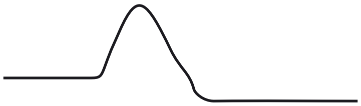
1. Tapping or slapping apex impulse is typically felt in MS. It is due to palpable first sound.
2. Forcible or hyperdynamic apex impulse is felt in diastolic overload of left ventricle (LV) (mitral regurgitation [MR], AR, VSD, PDA, hyperdynamic states).
3. Sustained heaving apex impulse is felt in systolic overload with left ventricular hypertrophy (LVH) (AS, HT, coarctation of aorta). In obese persons and in emphysema, it is difficult to localize apex beat.
4. Double impulse or diffuse impulse is due to dyskinetic or aneurysmal segment of LV. Also double impulse is felt in HOCM and combined AS and AR.

Abnormal precordial pulsations

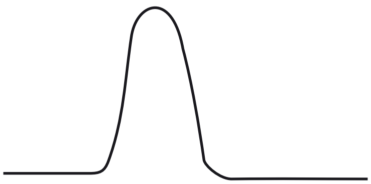
Palpate with flat of hand or ulnar aspect of hand over left parasternal plane in 4th and 5th ICSs. In systolic right ventricular overload and RVH as



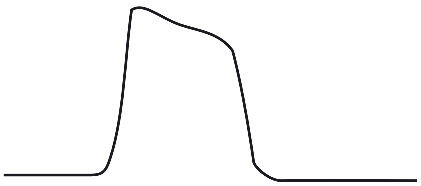
Normal



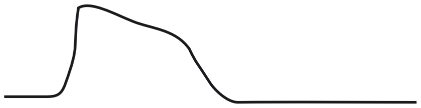
Tapping (ill sustained hypodynamic)
Mitral stenosis



Hyperdynamic (ill sustained, forcible)
Mitral incompetence, aortic incompetence



Heaving (sustained, forcible)
Aortic stenosis, hypertension



Diffuse (dyskinetic)

Figure 3.15 Types of apex beat.

seen in PHT and pulmonary stenosis, sustained right ventricular heave can be palpated. In diastolic overload (e.g. tricuspid incompetence [TI]), an abrupt hyperdynamic pulsation is felt. Try and appreciate precordial rock and roll. Keep full flat of right hand over precordial region with fingers at the apex. In marked LVH/dilation during systole, the fingers rock (lifted up) while the palm over parasternal region (RV) rolls in (depressed). Opposite rock is felt in marked RVH/dilatation i.e. RV rocks (palm lifted up) and LV rolls (fingers depressed).

Palpable precordial sounds

- Palpable S1 and OS at the apex in MS
- Palpable S4 at apex or parasternally in LVF
- Pericardial knock in constrictive pericarditis and S3 in LVF and MR can be felt
- Aortic ejection click in right 2nd ICS parasternally in congenital valvular AS and aortic root dilatation
- Pulmonary ejection click in left 2nd ICS parasternally in pulmonary valve stenosis and pulmonary artery (PA) dilatation. Aortic and pulmonary ejection clicks are better felt in sitting and bending forward position

Keep ulnar surface of right hand over left 2nd space to palpate PA pulsations. In PHT, loud pulmonary second sound is palpable as a diastolic shock in the pulmonary area. Similarly, palpate right 2nd ICS and suprasternal notch for aortic pulsations due to unfolding of aorta or aneurysm of aorta.

Precordial thrills

At mitral area palpate diastolic (MS), and systolic (MR) thrills. Systolic thrill in midprecordial region (left parasternal plane) in VSD, systolic thrills in aortic (AS) and pulmonary (PS) areas. In ASD, systolic thrill in pulmonary area due to excessive flow across pulmonary valve may be present. Similarly, diastolic thrills at base of heart may be felt in AR and pulmonary regurgitation (PR). In PDA and rupture of sinus of Valsalva, continuous thrill is felt at the base of heart.

Palpation beyond precordium

1. **Epigastric region** – RV pulsations, pulsatile liver (TR), aortic pulsation (atherosclerotic aorta, aortic aneurysm-expansile pulsations) (Box 3.13).
2. **Neck** – Dancing carotids (AR, PDA). Thrill felt over carotids in AS and carotid narrowing (atherosclerosis, Takayasu's disease), aneurysm of arch of aorta. Thrill felt over subclavian arteries due to narrowing (same causes). Cervical rib (thoracic outlet syndrome) may cause kinking of subclavian artery producing a thrill and a bruit.
3. **Suprasternal notch** – Pulsations due to unfolded aorta, aneurysm of arch of aorta and aberrant right subclavian artery (Box 3.14).
4. **Right sternoclavicular pulsations** – Due to aneurysm of innominate artery.

Causes of epigastric pulsations

Box 3.13

- Normal aorta pulsations in thin individuals
- Right ventricular hypertrophy
- Tricuspid regurgitation (pulsatile liver)
- Abdominal aorta aneurysm (Expansile pulsations)
- Tumor in front of abdominal aorta

Causes of suprasternal pulsations

Box 3.14

- Aortic incompetence
- Aortic arch aneurysm
- Coarctation of aorta
- Thyroid ima artery
- Abnormal origin of right subclavian artery

5. **Intercostal pulsations** – Found particularly in back in coarctation of aorta (Suzman's sign).

Percussion

With the advent of imaging tools, percussion is losing its importance, particularly in the west. To outline left border of heart, start percussion from left anterior axillary plane in 3rd, 4th and 5th ICSs (preferably even one space below apex) moving towards sternum till an impaired note is elicited as one reaches the left border of the heart. Left border of heart is shifted out with cardiac dilatation, pericardial effusion and shift of mediastinum to left. In pericardial effusion, left border lies below and outside cardiac impulse. It is difficult to define right border of heart (formed by the right atrium) as it lies just outside the right lateral sternal plane. To percuss the right border of heart, one should first define the upper border of liver dullness and start percussion one space above from right midclavicular plane towards sternum till dull note is elicited. Percussible right heart border is due to right atrial enlargement or pericardial effusion, aneurysm of AA and mediastinal shift to right side. Dilatation of PA or aorta produces a dull note over left and right 2nd space just lateral to sternal borders respectively. Normally, direct percussion over sternum gives a resonant note, but in the presence of retrosternal tumors (thyroid, thymus, aneurysm of aortic arch) and pericardial effusion, dull note is elicited.

Auscultation

Areas of auscultation (Fig. 3.16)

These areas do not correspond to surface markings of respective heart valves (Fig. 3.17) but denote areas where events at these four valves are appreciated best.

Mitral area overlies the apex beat; tricuspid area is over the 5th ICS just to the left of sternum. The pulmonary area is over the left 2nd ICS along the lateral sternal border. Aortic I area is over right 2nd space along the right lateral sternal border and aortic II area (Erb's area) is over the left 3rd space in the parasternal plane.

Heart sounds (Fig. 3.18)

The first (S1) and second (S2) heart sounds should be first identified. Intensity of sounds and splitting if present should be noted. S1 is better appreciated

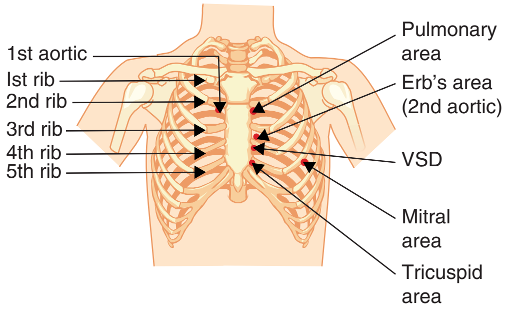


Figure 3.16 Areas of auscultation of heart.

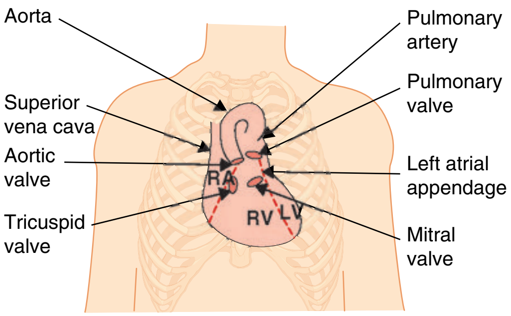
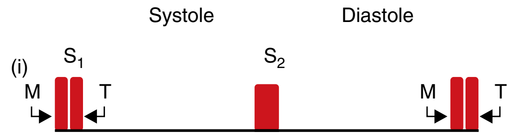
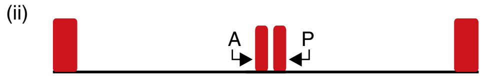


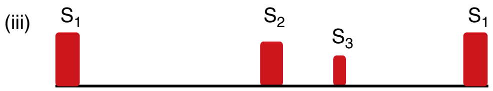
Figure 3.17 Surface markings of cardiac valves and cardiac chambers. Note – Valve positions do not correspond to respective areas of auscultation.


Systole
Diastole
(i)
S_1
S_2
M
T
M
T

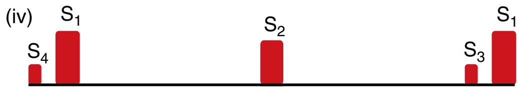
Normal splitting of first heart sound
Mitral (M) component precedes
tricuspid (T) component



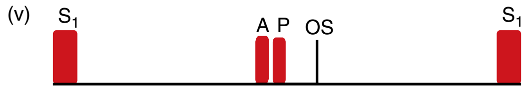
Normal splitting of second heart sound
Aortic (A) component precedes pulmonary (P) component


(iii)
S_1
S_2
S_3
S_1

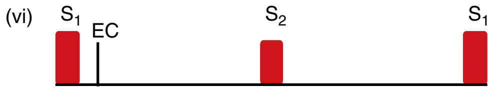
S_3 follows S_2


(iv)
S_4
S_1
S_2
S_3
S_1

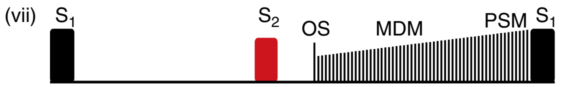
S_4 follows S_1



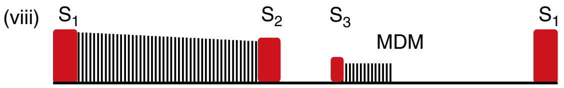
Splitting of S_2 and opening snap (OS) best heard at mitral area in MS


(vi)
S_1
EC
S_2
S_1

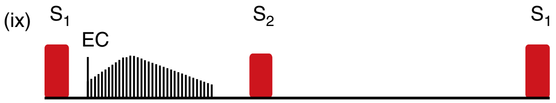
Ejection click (EC) heard at base of heart during systole


(vii)
S_1
S_2
OS
MDM
PSM
S_1

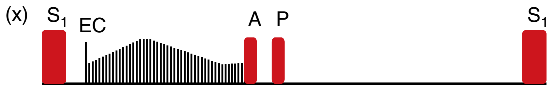
Auscultatory findings in mitral stenosis (loud & sharp S_1 opening snap followed by long mid diastolic rumbling murmur (MDM) and presystolic accentuation (PSM)


(viii)
S_1
S_2
S_3
MDM
S_1

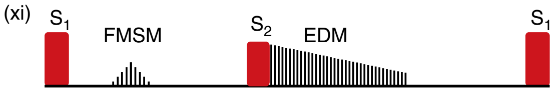
Auscultatory findings in organic mitral incompetence (high pitched pansystolic murmur, S_3 followed by short mid diastolic flow murmur)


(ix)
S_1
EC
S_2
S_1

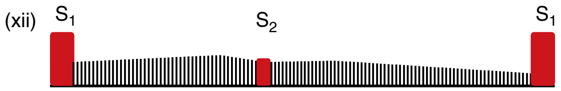
Auscultatory findings in aortic stenosis (ejection click (EC) followed by mid systolic ejection murmur) and a single S_2 heard over aortic area



Auscultatory findings in pulmonary stenosis (ejection click followed by crescendo-decrescendo murmur with wide splitting of II sound) heard over pulmonary area


(xi)
S_1
FMSM
S_2
EDM
S_1

Auscultatory findings in aortic incompetence (early decrescendo diastolic murmur) heard best over second aortic area and along sternal border. Functional mid systolic murmur (FMSM) may be heard



Auscultatory findings in patent ductus arteriosus (continuous machinery murmur throughout systole and diastole).

Figure 3.18 Heart sounds and murmurs.

over mitral area, whereas S2 is appreciated better over pulmonary area. S1 is loud and snappy in MS. S2 (pulmonic component) is loud and closely split in PHT. In long-standing cases of HT, S2 (aortic) has a ringing quality and is appreciated over aortic I area. In syphilitic aortitis, S2 has a tambour quality.

The S1 is produced by closure of mitral and tricuspid valves; when split, the first component is of mitral origin and the second component is of tricuspid origin. The S2 is due to closure of aortic and pulmonary valves, the first component being aortic and the second component being pulmonary. Both components are better heard over the pulmonary area. The S3 is due to stretching of the papillary muscle and chordae tendineae during the maximum filling phase of ventricular diastole. It may be a normal finding in children. It follows 0.16 seconds after the aortic component of S2. In CCF, it is audible as a protodiastolic gallop rhythm. S4 is produced during atrial systole by the tensing of mitral or tricuspid valve cusps. It is not audible normally. In LVF when there is forceful atrial contraction, S4 is heard as presystolic gallop. Thus, S3 except in children indicates heart failure, over mitral area (LVF) and over tricuspid area right ventricular failure (RVF) (triple rhythm). Summation gallop (summation of S3 and S4) is heard sometimes in heart failure (Fig. 3.19) (for causes of S3 and S4, see Box 3.15 and 3.16, respectively).

Abnormalities of heart sounds

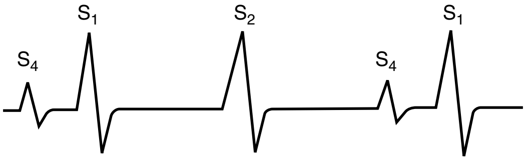
1st heart sound

It may vary in intensity from soft to loud.

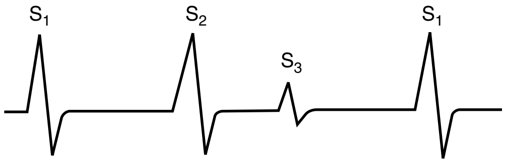
1. **Soft** – LVF, low cardiac output, long P-R interval (first-degree heart block), MR, TR and calcific valves
2. **Loud** – MS, short P-R interval, large stroke volume, atrial myxoma and TS (tricuspid area).
3. **Changing intensity of S1** – AF and complete heart block

2nd heart sound

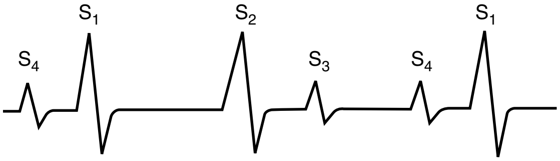
1. **Soft** – Calcific AS, AI and pulmonary stenosis
2. **Loud** – PHT (pulmonary component), systemic HT (aortic component), syphilitic AR (tambour quality) and ascending aortic aneurysm
3. **Absent P2** in Fallot's tetralogy



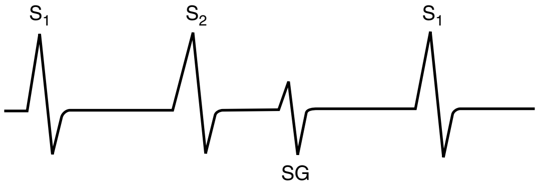
Presystolic gallop (S_4)



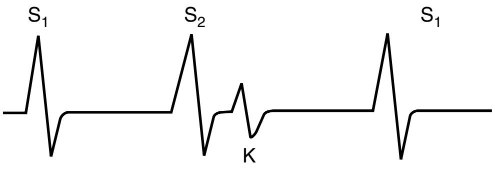
Protodiastolic gallop (S_3)



Quadruple rhythm (S_3 & S_4)



Summation gallop (SG)



Pericardial knock (K)

Figure 3.19 Gallops and pericardial knock.

Causes of 3rd heart sound Box 3.15

Physiological
- Children
- Healthy young persons
- Athletes
- Pregnancy

Pathological
- Congestive cardiac failure
- Mitral incompetence
- Tricuspid incompetence
- Atrial septal defect (tricuspid area)
- Ventricular septal defect and PDA (mitral area)
- Constrictive pericarditis (knock sound)
- Hypertrophic obstructive cardiomyopathy (mitral area)

Causes of 4th heart sound Box 3.16

- Always pathological
- Due to forceful contraction of left atrium (LA)
- Causes are LVF, systemic HT, CAD (AP, AMI), ventricular aneurysm and HOCM

4. **Splitting of S2** (Fig. 3.20)
   a. Split can widen on inspiration in right bundle branch block (RBBB), pulmonary stenosis and PHT
   b. Split can widen on expiration (reverse splitting) in AS and left bundle branch block (LBBB)
   c. Wide and fixed split – ASD

Additional sounds

Systolic clicks

- Systolic click is due to opening of semilunar valves (aortic and pulmonary). Valve opening is normally silent but may be heard in aortic or pulmonary stenosis, produces a click in early systole, preceding the ejection systolic murmur, provided valve cusps are pliant and not calcified (congenital stenosis) (Fig. 3.18).
- In MVP, midsystolic click followed by systolic murmur is heard over mitral area.

Opening snap – In MS, raised left atrial pressure causes forceful opening of mitral valve (MV)

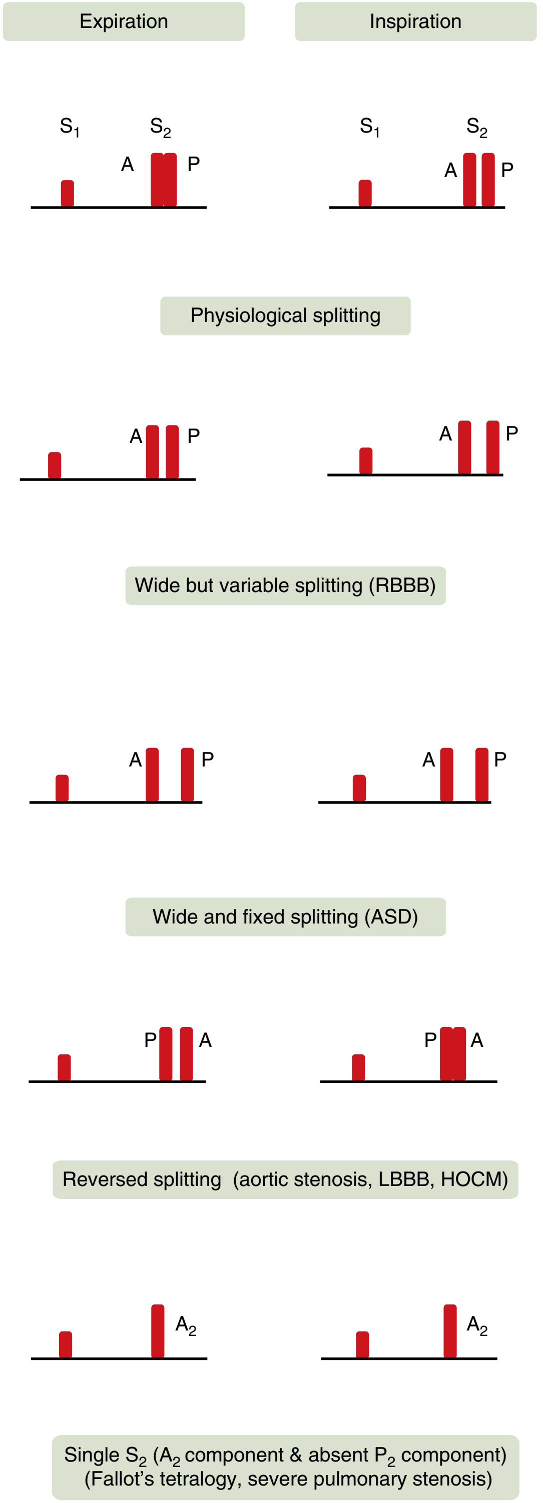

Expiration
Inspiration
S_1
S_2
A
P
S_1
S_2
A
P
Physiological splitting
A
P
A
P
Wide but variable splitting (RBBB)
A
P
A
P
Wide and fixed splitting (ASD)
P
A
P
A
Reversed splitting (aortic stenosis, LBBB, HOCM)
A_2
A_2
Single S_2 (A_2 component & absent P_2 component)
(Fallot's tetralogy, severe pulmonary stenosis)

Figure 3.20 Normal and abnormal splitting of S2 and single S2. A – aortic component, P – pulmonary component.

Differences between OS and 3rd heart sound (S3)

Box 3.17

Features	Opening snap (mitral)	S3 (mitral)
■ Cardiac cycle phase	Diastolic	Diastolic
■ Timing from S2	30–150 msec	>150 msec
■ Site	Above and medial to apical impulse	At apex
■ Pitch	High	Low
■ Character	Snappy	Thud
■ Associated murmur	Low-pitched rumbling mid-diastolic murmur (MDM) of MS	High-pitched pansystolic murmur of MR and mid-diastolic flow murmur
■ S1	Loud and sharp	Soft or replaced by the systolic murmur
■ Effect of standing	S2-OS interval widens	S2-S3 interval unchanged

leaflets. Opening snap is heard in early diastole and is followed by mid-diastolic rumbling murmur with presystolic accentuation (Fig. 3.18). For differences between OS and S3, see Box 3.17.

Murmurs

Murmurs are due to turbulence of blood flow (Fig. 3.18). The timing and intensity of a murmur depends upon the anatomical defect and the pressure gradient across the defect. Stenotic lesions offer obstruction to forward flow of blood. In incompetent valves, there is regurgitation of blood. In septal defects and shunts, there is abnormal flow of blood from high-pressure to low-pressure chamber across the defect.

Following characters of murmur(s) should be noted.

1. Timing in the cardiac cycle
2. Location where best audible
3. Intensity (grade) and any special character
4. Selective conduction
5. Alteration with breathing or change of posture
6. Effect of drugs
7. Effect of exercise

Timing in the cardiac cycle

1. **Systolic murmurs**
    a. **Pansystolic murmur** – Pansystolic murmur starts with the 1st heart sound and merges with the 2nd heart sound (occupies whole of systole). It is classically heard in MR (heard best over mitral area), TR (heard best over tricuspid area) and VSD (best localized over left 4th ICS in parasternal plane-midprecordial area).

    Causes and special features of pansystolic murmurs
    - Mitral regurgitation – Best heard at apex, radiates to axilla, increases on expiration
    - Ventricular septal defect – Best heard at left parasternal (3rd and 4th ICSs), increases on expiration
    - Tricuspid regurgitation – Best heard at left lower sternal border, increases on inspiration, associated hepatic systolic expansile pulsations and giant 'v' waves in JVP
    - Ruptured chordae tendinae – Causes very loud pansystolic murmur over apex, may radiate to right upper chest and axilla, increases on expiration

    b. **Ejection systolic murmur (midsystolic murmur)**
        i. **Functional due to increased flow through normal valves – Causes are**
        - Fever – Heard better over pulmonary area
        - Pregnancy

        - Bradycardia resulting in increased stroke volume in athletes
        - Atrial septal defect (increased flow across pulmonary valve causing ejection systolic murmur over pulmonary area)
        - Aortic regurgitation (increased flow across aortic valve, causing ejection systolic flow murmur)
      ii. **Organic** – The murmur starts after ejection click and ends before the 2nd heart sound. It is usually crescendo–decrescendo in character with maximum intensity during midsystole. Causes are
        - Aortic stenosis
        - Pulmonary stenosis
        - Hypertrophic obstructive cardiomyopathy
        - Atherosclerotic aortic valve disease
        - Systemic and pulmonary hypertension
   c. **Long systolic murmur** – The long systolic murmur starts with S1 and ends short of S2. It is heard in functional MR or TR.
   d. **Late systolic murmur** – Late systolic murmur begins in midsystole and is usually preceded by a midsystolic sound (heard in floppy MV syndrome or papillary muscle dysfunction).

2. **Diastolic murmurs**
   a. **Early diastolic murmur (EDM)** – Starts soon after S2, decrescendo in character and heard in AR and PR. Early diastolic murmur of AR is better heard in aortic II area (Erb's area) with diaphragm of stethoscope pressed against chest wall with the patient in sitting position, leaning forward and in expiratory apnea. In PR (usually seen in PHT), the EDM (Graham Steell's murmur) is very short and best heard over pulmonary area. Pulse volume helps to differentiate between AR (large volume) and PR (small volume).
   b. **Mid-diastolic murmur**
      i. In MS, a mid-diastolic rumbling, harsh murmur localized to mitral area is present. A similar murmur over tricuspid area may be heard in T.
      ii. In acute rheumatic fever, a short MDM (Carey Coomb's murmur) due to acute mitral valvulitis is audible in some cases. It disappears once the carditis resolves.
      iii. In MR, VSD and PDA, high flow across mitral valve and in ASD high flow across tricuspid valve produces mid-diastolic soft flow murmur (in mitral and tricuspid areas, respectively). There is no diastolic thrill, OS or loud S1.
   c. **Presystolic murmur (PSM)** – It is typically heard in MS. It is due to forceful contraction of LA. It is crescendo in character and ends in loud snappy S1. In AF, the murmur disappears. It is best heard in mitral area. A similar murmur is present in TS. It is heard in left 4th or 5th ICS in left parasternal line or in epigastrium.

   The murmurs (MDM, PSM) of MS are louder in expiration and in left lateral position. It is best heard with bell of the stethoscope. In TS, the murmur increases with inspiration and in right lateral decubitus. (For details, see clinical cases of MS and TS.)

3. **Continuous murmurs**
   Continuous murmurs are audible uninterruptedly throughout systole and diastole with S2 drowned in the murmur. The blood flow is in the same direction from high- to low-pressure area all throughout as against to-and-fro murmurs (where the direction reverses in diastole). Causes are PDA, aortopulmonary window, arteriovenous shunts and ruptured sinus of Valsalva.
4. **To-and-fro murmurs**
   These are biphasic murmurs, heard when there is combined AS and AR. The murmur does not cover (obliterate) the 2nd sound.
5. **Venous hum**
   This is sometimes mistaken for a continuous murmur. It is caused by blood flowing through large veins in high-output states. It

has a humming quality, and it disappears with local pressure over the vein. Heard at root of neck.

Location of valvular murmurs

• Mitral stenosis	Mitral area (inside and a little above the apex)
• Mitral regurgitation	At the apex (mitral area)
• Aortic stenosis	Valvular, right 2nd space, parasternally (aortic I area) Subvalvular, left 3rd ICS parasternally (aortic II area)
• Aortic incompetence	Best over aortic II area, i.e. left 3rd ICS parasternally (Erb's area) Also heard over right 2nd ICS parasternally (aortic I area)
• Pulmonary stenosis and regurgitation	Left 2nd ICS parasternally (pulmonary area)
• Tricuspid stenosis and incompetence	Left 4th, 5th ICS (tricuspid area)

Intensity of murmur

1. Systolic murmurs are classified into grades 1–6 (Levine's grading)
   Grade I – Very faint, just heard in quiet surroundings
   Grade II – Easily audible
   Grade III – Moderately loud but without thrill
   Grade IV – Loud with thrill, audible with full chest piece of the stethoscope
   Grade V – Very loud with thrill, heard even with edge of the stethoscope chest piece placed on chest
   Grade VI – Loudest possible, with thrill, audible even with the chest piece held above the located area
2. Diastolic murmurs (DM) are classified into four grades (from 2 to 5 of above).

Pitch and quality of murmur vary according to the degree of leak, e.g. large leaks produce low-pitched murmur, whereas small leaks produce high-pitched murmur. Intensity of murmur depends upon force of ventricular contraction. In severe LVF the murmurs become faint or may even disappear.

Selective conduction of murmurs

The conduction of a murmur depends upon the direction of blood flow. For example, in mitral incompetence, blood leaks from LV to LA which lies posteriorly, hence pansystolic murmur radiates selectively from mitral area towards posterior axillary and scapular planes on the left side.

In MS, murmur is due to obstruction to blood flow from LA to LV. Here the flow is from LA (which is posterior to LV) to LV, the direction of flow is posterio-anterior towards the apex, and hence there is no conduction.

In AS, midsystolic ejection murmur is best heard over aortic I area and is selectively conducted to carotids in the direction of the blood flow.

In AI, since EDM is due to leakage of blood from the aorta to LV, conduction is along left sternal border towards apex (the direction of leak).

Effect of posture and breathing

Aortic and pulmonary murmurs are best audible with patient sitting and leaning forward. Mitral murmurs are better heard with patient in left lateral position. Murmurs from left side of heart (mitral and aortic) are better audible during expiration, whereas murmurs from right side of heart (tricuspid and pulmonary) are accentuated during inspiration. In standing position, most murmurs diminish in intensity, but murmurs of HOCM and MVP become louder on standing. With squatting, murmurs of HOCM and MVP diminish, but most murmurs become louder.

Effect of drugs

Amyl nitrite inhalation accentuates AS murmur but decreases murmurs of mitral incompetence, AI and VSD. However, during the late tachycardia phase after amyl nitrite, murmurs of MS, TS, TI and PS increase. Vasoconstriction by phenylephrine causes opposite effects.

Effect of exercise

All stenotic lesions (MS, AS, PS) become louder with both isotonic and submaximal isometric (handgrip) exercise. Also murmurs of MR, AR and VSD become louder with handgrip, and murmur of HOCM usually decreases with handgrip.

Effect of Valsalva maneuver

Valsalva maneuver (VM) reduces left ventricular size and also decreases venous return to right atrium. Valsalva maneuver increases murmurs of HOCM and MS but decreases murmurs of AS, MR and TS.

Functional or hemic murmurs

There is no anatomical defect. These are usually systolic, invariably without thrill, best audible over base of heart (pulmonary and aortic areas) and change considerably with change in posture. These are commonly heard in fevers, anemia and pregnancy (Table 3.2).

Prosthetic valve sounds

These vary with the type of prosthetic valve. Metallic valves produce clicking sounds of valve opening and closing. Tissue (biological) valves do not produce clicking sounds. They produce sounds like normal heart valves.

Tumor flop sound – It is heard in atrial myxoma which is mobile and has a long pedicle. It is heard during diastole.

Pericardial rub

Pericardial rub is synchronous with the heartbeat and has a to-and-fro coarse character. It is not altered by breathing as against pleural or pleuropericardial rubs which change with breathing.

Table 3.2 **Differences between organic and functional murmurs**

Features	Organic	Functional
Thrill	Usually present	Absent
Change with posture	No change	Often change
Change over time	Worsen	May become less or disappear

Auscultation over arteries

In AR, pistol shot sound (loud S1) and a systolic–diastolic murmur (Duroziez murmur) are heard over the femorals. For appreciating this murmur, one has to adjust the pressure of the chest piece over the femoral artery.

In arteriovenous fistula, continuous murmur is audible, and the site depends upon the location of arteriovenous fistula (Box 3.18).

Bruits are heard over stenotic arteries (Box 3.19).

Auscultation over veins

In hyperdynamic circulation (hyperthyroidism, anemia), a continuous humming sound is heard over internal jugular veins. In Cruveilhier–Baumgarten syndrome (cirrhosis of liver with portal HT), a venous hum is heard over dilated paraumbilical veins over abdomen (see Fig. 2.21).

Fundus examination

Examination of cardiovascular system is incomplete without ocular fundus examination especially in patients with HT, IE and SVC obstruction.

Locations of some arteriovenous fistulae — Box 3.18

Carotido-cavernous fistula	Eyeball
Vascular tumors of brain	Skull
Hyperthyroidism	Thyroid
Pregnancy	Uterus
Paget's disease of bones	Bones

Locations of some vascular bruits — Box 3.19

Carotid artery	Anterior triangle of neck
Vertebral artery	Posterior triangle of neck
Subclavian artery	Supraclavicular region
Renal artery	Flanks
Abdominal aorta	Epigastric region

CLINICAL CASES

A case of rheumatic fever

1. **Introduction** – Rheumatic fever is an immune mediated connective tissue disease that follows throat infection caused by Group-A β-hemolytic *Streptococci*. The primary sites of affliction are heart, joints and central nervous system. The most important sequela of rheumatic fever is rheumatic heart disease (RHD) which results in significant morbidity and mortality.
2. **Clinical features of rheumatic fever (Fig. 3.21)** – The American Heart Association recommends the revised Jones criteria as a guide for diagnosis of acute rheumatic fever
    a. **Major criteria**
        i. **Carditis** – The carditis of acute rheumatic fever is actually a pancarditis with involvement of pericardium, epicardium, myocardium and endocardium. Carditis occurs in 40–60% of the cases of rheumatic fever. It most often involves the MV. The Carey Coomb murmur of acute rheumatic fever is a sign of active mitral valvulitis. It is a soft high-pitched diastolic murmur. Pericarditis, pericardial effusion and arrhythmias (first, second and third-degree heart blocks) are other features of rheumatic carditis. Rheumatic heart disease is the only residual sequela of acute rheumatic fever.
        ii. **Polyarthritis** – It occurs in almost 75% of the cases. It presents as red, swollen, warm and tender joints and is typically migratory in nature. Mostly large joints are involved, and resolution occurs over 6 weeks.
        iii. **Chorea** – It is a late-onset manifestation, occurring as late as 3 months following throat infection. There are choreoathetoid movements sometimes associated with emotional lability.
        iv. **Erythema marginatum** – Though unique, it is an infrequent clinical finding seen in less than 10% of the patients.
        v. **Subcutaneous nodules** – These present as nontender, firm, pea-sized nodules on the extensor surfaces of joints like knees, elbows and spine. Rheumatic nodules are seen in less than 3% of the patients.
    b. **Minor criteria**
        i. **Fever** – It ranges from 101°–102°F.
        ii. **Arthralgia** – It is diagnosed only in the absence of underlying arthritis.

Evidence of Group-A streptococcal infection (given below).

3. **Laboratory diagnosis**
    a. **Throat culture** – Positive throat culture for Group-A β-hemolytic *Streptococci* at the time of rheumatic fever has diagnostic significance.
    b. **Streptococcal antibody test** – Antistreptolysin O (ASO) titer is raised in 80% of the patients. (Anti-DNase B antibody level is advocated if ASO titer is not elevated.)
    c. **Acute phase reactants** – Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are raised in almost all patients with carditis and arthritis and sometimes in patients with chorea.

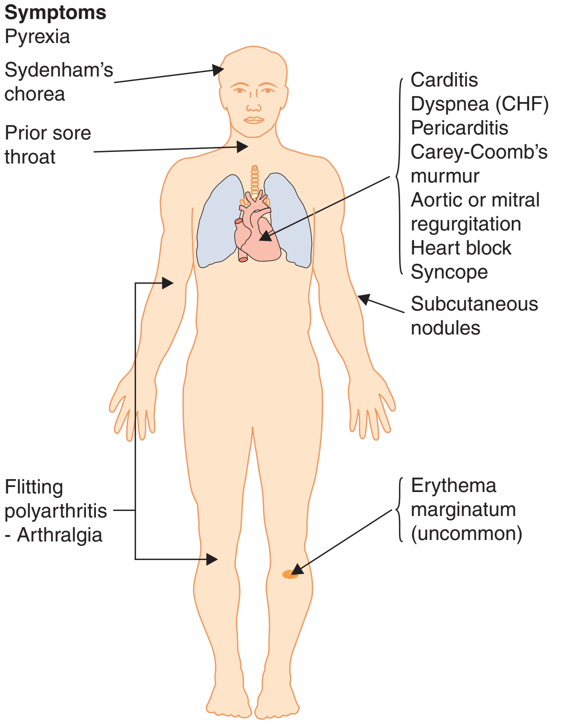


Figure 3.21 Clinical features of rheumatic fever.

   d. **Electrocardiogram** – Prolonged P-R interval, though seen in all cases with carditis, is a nonspecific finding.
4. **Diagnosis** – Two or more major or one major + two or more minor criteria are necessary for diagnosis with one supporting evidence of preceding streptococcal infection of acute rheumatic fever (given below).
   a. History of recent sore throat or scarlet fever.
   b. High ASO titer.
   c. Positive throat culture for Group-A *Streptococcus*.
5. **Management**
   a. **Treatment**
      i. **Treatment of Group-A streptococcal infection** – All patients with acute rheumatic fever should be treated for streptococcal infection at the time of diagnosis irrespective of isolation of the organism. Oral penicillin for 10 days or a single intramuscular injection of benzathine penicillin in a dose of 1,200,000 units can be given. Patients allergic to penicillin should be given erythromycin (500 mg BD) for 10 days.
      ii. **Treatment of clinical manifestations**
      Arthritis – Salicylates give prompt relief. Aspirin in a dose of 100 mg/kg/day to attain a serum level of 20 mg% is required. The dose should be reduced gradually based on clinical and laboratory response (ESR and CRP).
      Carditis – In the absence of CCF, salicylates are beneficial; however, corticosteroids are required if cardiac failure or severe carditis is present.
      Sydenham chorea – In mild cases, diazepam is sufficient; however, in severe cases, haloperidol may be required.
   b. **Prevention**
      i. **Primary prophylaxis** – Aims at treatment of streptococcal throat infection with a course of antibiotics to prevent the development of acute rheumatic fever.
      ii. **Secondary prophylaxis** – In presence of valvular heart disease, some recommend life-long prophylaxis. This should be continued even after valve surgery. Patients without cardiac involvement should be given prophylaxis until 5 years after the attack of rheumatic fever or till the age 21 years, whichever is longer.

Viva voce

Q1. What are the clinical criteria for the diagnosis of acute rheumatic carditis?

- Presence of rheumatic nodules and/or erythema marginatum is strongly associated with carditis
- Evidence of pericarditis
- Evidence of myocarditis (tachycardia, soft S1, S3 gallop, evidence of CCF, cardiomegaly, various types of heart blocks, arrhythmias)
- Evidence of endocarditis (Carey Coomb's murmur, mild MR [soft systolic murmur], mild AI [EDM]); alteration of existing heart murmurs (in case of recrudescence of rheumatic fever)

A case of mitral stenosis (MS)

1. **Introduction** – MS is the most frequent valve lesion of established RHD. In Indian subcontinent and Srilanka it can be present at young age (juvenile MS).
   a. Mitral valve dimensions
      i. Normal valve 4–6 cm^2
      ii. Symptomatic stenosis less than 2.5 cm^2
      iii. Tight MS 0.8–1.0 cm^2
2. **Causes of MS**
   a. Rheumatic fever (almost all cases)
   b. Rare causes – Congenital mucopolysaccharidoses (Hurler's and Hunter's syndromes), malignant carcinoid, methysergide treatment, amyloidosis, systemic lupus erythematosus (SLE), rheumatoid arthritis and atrial myxoma (mimics MS).
3. **Clinical features (Figs. 3.22 and 3.23)**
4. **Investigations**
   a. **Electrocardiogram** – P-mitrale (see Fig. 10.4), right axis deviation, RVH (see Chapter 10, Quiz 7). Atrial fibrillation may be seen in chronic cases (see Chapter 10, Quiz 3).
   b. **Chest X-ray**
      i. Left atrial hypertrophy (LAH), RVH, right atrial hypertrophy (RAH) (Fig. 3.24)
      ii. Pulmonary venous HT (early cases)

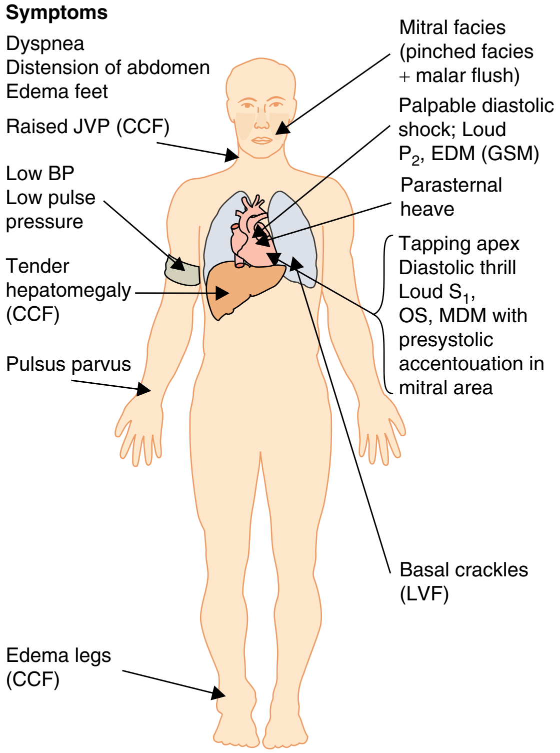
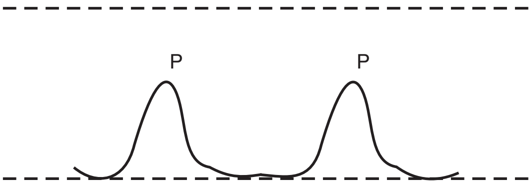
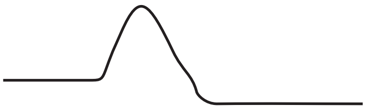

Symptoms
Dyspnea
Distension of abdomen
Edema feet
Raised JVP (CCF)
Low BP
Low pulse pressure
Tender hepatomegaly (CCF)
Pulsus parvus
Edema legs (CCF)
Mitral facies (pinched facies + malar flush)
Palpable diastolic shock; Loud P_2, EDM (GSM)
Parasternal heave
Tapping apex
Diastolic thrill
Loud S_1,
OS, MDM with presystolic accentuation in mitral area
Basal crackles (LVF)

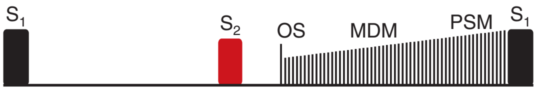
Figure 3.22 Salient clinical features of MS with PHT. GSM – Graham Steell's murmur.



Pulsus parvus (MS)



Tapping (ill sustained hypodynamic) apex impulse
Mitral stenosis


S_1
S_2
OS
MDM
PSM
S_1

Auscultatory findings in mitral stenosis (loud & sharp S_1 opening snap followed by long mid diastolic rumbling murmur (MDM) and presystolic accentuation (PSM)

Figure 3.23 Mitral stenosis – important clinical signs.

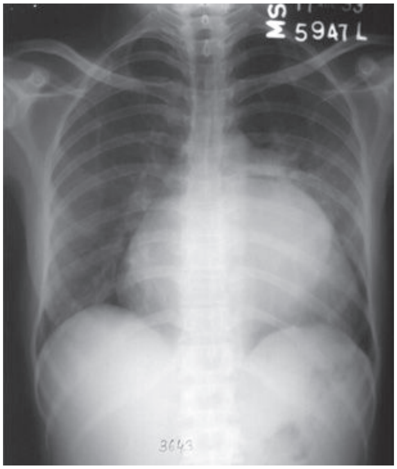

MS
5947 L
3643

Figure 3.24 Mitral stenosis – gross left atrial enlargement (LAE) (double shadow).

iii. Pulmonary arterial HT (long-standing severe cases)

iv. Rarely calcification of MV in late stages

Left atrial appendage and PA enlargement cause straightening of left border (mitralization); carina is splayed. LAE is best appreciated in lateral view with barium swallow. Enlarged LA causes posterior displacement of barium-filled esophagus (Fig. 3.25). Pulmonary venous HT is diagnosed by redistribution of blood flow to the upper lobe veins (an X-ray picture of Sargent with moustache folded upwards is shown in Fig. 3.26). In severe pulmonary venous HT, Kerley's A and B lines are visible in peripheral lung fields (Fig. 3.27).

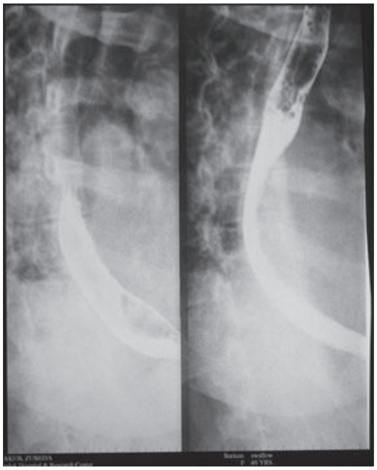


Figure 3.25 Mitral stenosis with LAE (barium swallow, lt. lateral view).

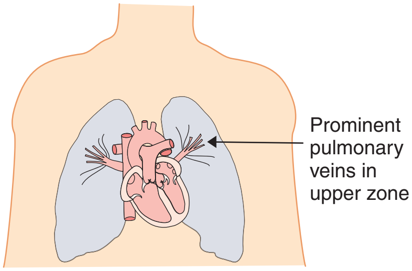

Prominent
pulmonary
veins in
upper zone

Figure 3.26 X-ray in a case of MS with pulmonary venous HT (simulating picture of a Sargent with moustache turned upwards).

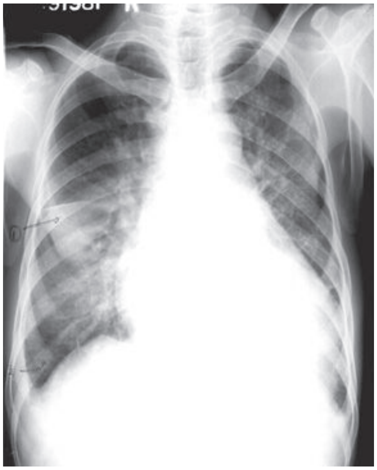


Figure 3.27 Mitral stenosis (mitralization) with Kerley's A and B lines.

In long-standing severe stenosis with pulmonary arterial HT, X-ray shows prominent pulmonary arteries with peripheral oligemia (Sargent with moustache pointing downwards) (Fig. 3.28). Heart is enlarged because of RV, LA and RA enlargement.

- **c. 2D-echocardiogram** – 2D echo assesses severity of MS, chamber enlargement, presence of left atrial thrombus and excludes left atrial myxoma.
- **d. Cardiac catheterization** – Indications are
  - **i.** With restenosis before open heart surgery
  - **ii.** In elderly patients (to exclude IHD)
  - **iii.** For assessing coexistent MR

5. Complications

- **a.** Left atrial failure, congestive heart failure (Figs. 3.29–3.31)
- **b.** Atrial premature beats, atrial flutter, AF

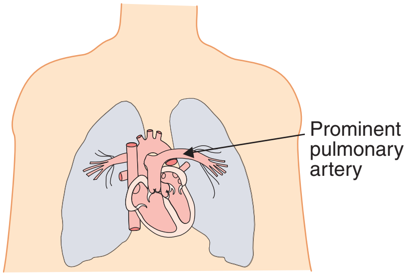

Prominent
pulmonary
artery

Figure 3.28 X-ray in a case of advanced MS with pulmonary arterial HT (simulating picture of a Sargent with moustache turned downwards).

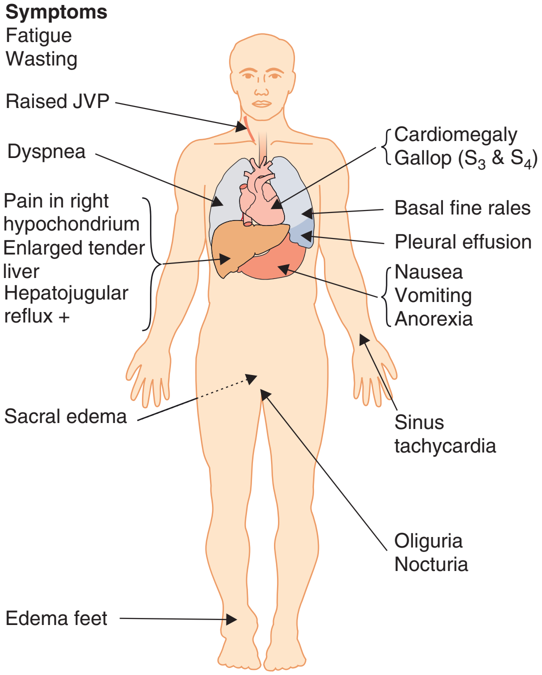

Symptoms
Fatigue
Wasting
Raised JVP
Dyspnea
Pain in right hypochondrium
Enlarged tender liver
Hepatojugular reflux +
Sacral edema
Edema feet
Cardiomegaly
Gallop (S_3 & S_4)
Basal fine rales
Pleural effusion
Nausea
Vomiting
Anorexia
Sinus tachycardia
Oliguria
Nocturia

Figure 3.29 Clinical features of CCF.

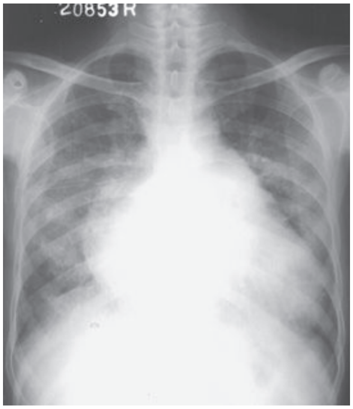


Figure 3.30 Congestive cardiac failure with pulmonary edema.

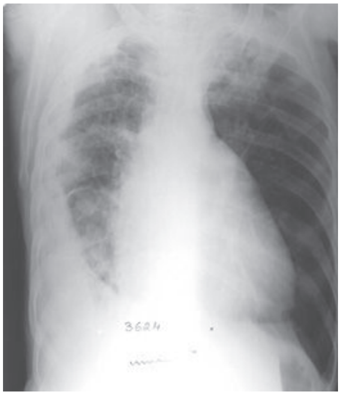


Figure 3.31 Congestive cardiac failure with right pleural effusion.

   - **c.** Left atrial clot with systemic embolization (stroke, gangrene, saddle thrombus)
   - **d.** Pulmonary HT
   - **e.** Pulmonary apoplexy (hemoptysis)
   - **f.** Pulmonary hemosiderosis in long-standing cases of MS
6. **Rare complications**
   - **a.** Infective endocarditis
   - **b.** Ortner's syndrome due to pressure on left recurrent laryngeal nerve by enlarged LA or dilated PA or tracheobronchial lymph nodes.
   - **c.** Dysphagia due to pressure of LA on esophagus (Fig. 3.25).
   - **d.** Bronchiectasis due to pressure on left main bronchus.
   - **e.** Cardiac cirrhosis (long-standing CCF).
6. **Prognosis** – Patients with NYHA Class III dyspnea have 85% 10-year mortality, whereas NYHA Class IV patients have 100% mortality at 10 years.
7. **Management**
   - **a. Medical**
     - **i.** Treatment of CCF
       - Low salt diet
       - Diuretic (furosemide)
       - Digoxin useful with AF. Use with sinus rhythm controversial.
     - **ii.** Treatment of AF
       - Digoxin to control ventricular rate
       - Verapamil added if digoxin fails to control heart rate
       - DC cardioversion in young patients with recent-onset AF
       - Life-long oral anticoagulants
       - In persistent AF, oral anticoagulants are started followed by mitral valvotomy and then cardioversion is carried out. One may use oral quinidine along with digoxin for maintenance of sinus rhythm
     - **iii.** Rheumatic fever prophylaxis
     - **iv.** Infective endocarditis prophylaxis
   - **b. Surgical**
     - **i.** Balloon valvuloplasty
     - **ii.** Closed mitral valvotomy
     - **iii.** Open mitral commissurotomy
     - **iv.** Prosthetic valve replacement

Viva voce

Q1. Describe mitral facies.

In MS due to low cardiac output, coupled with severe PHT, there is vasoconstriction resulting in peripheral cyanosis seen over cheeks, lips and tip of nose. In addition, there may be malar flush due to vascular stasis resulting in pinkish-purple color of cheeks (appreciated better in fair skin persons, uncommon in Indian patients).

Q2. What factors determine intensity of S1?

1. P-R interval – Shorter the P-R interval, louder the S1 (e.g. sinus tachycardia)
2. Mitral valve or tricuspid valve cusps if wide open at the onset of ventricular systole (loud S1 in MS)
3. More pliable the valve cusps, louder the S1. S1 muffled with MV calcification

Q3. What is the differential diagnosis (DD) of mitral diastolic murmur?

- Mitral stenosis murmur (see page 71)
- Carey Coomb murmur (see page 71)
- Functional mid-diastolic flow murmur (see page 71)
- Austin Flint murmur – It is a functional, mid-diastolic low-pitched murmur heard over mitral area in severe AI. Aortic regurgitant jet impinges on the anterior mitral leaflet (causing narrowing of MV orifice) simultaneously when blood is flowing from LA to LV. There is no OS, no presystolic accentuation or loud S1. Associated

features of AI with peripheral signs are present. Isometric hand grip increases the Austin Flint murmur, and amyl nitrite inhalation diminishes Austin Flint murmur.

- Left atrial myxoma – Murmur varies with posture. Patient has constitutional symptoms such as fever, rash, arthralgia, high ESR, 2D echo is confirmatory.
- Ball valve thrombus – It floats in LA and obstructs mitral orifice during diastole; murmur is variable. 2D echo is confirmatory.
- Tricuspid stenosis – Box 3.22

Q4. Describe maneuvers to accentuate MS murmur.

- Use bell of the stethoscope
- Turn the patient in left lateral position while continuing to auscultate
- Auscultate in left lateral position after giving exercise (provided patient is not in failure)

Q5. How will you manage a patient of MS during pregnancy?

- Ideally, patients with severe valvular disease are advised to avoid pregnancy
- During pregnancy due to increased cardiac output, patient drifts from lower to higher grades of NYHA class dyspnea
- Patients require good nutrition, salt restriction, treatment of anemia and extra bed rest
- The philosophy is to carry the patient as far as possible to term. The patient is monitored closely and treated as indicated.
- Hospitalization with Grade 3 NYHA class dyspnea.

Specific interventions include

- Mitral valvotomy with severe symptoms
- Early therapeutic abortion with repeated heart failure or Grade 4 failure
- Treatment of heart failure with digoxin, diuretics, bed rest and salt restriction. Angiotensin-converting enzyme (ACE) inhibitors are contraindicated
- To avoid stress of 2nd stage of labor, caesarean section is advised.

Q6. What are the parameters to judge severity of MS?

- S2 to OS distance – Shorter the distance, more severe the MS
- Length of MDM (longer the murmur, severer the MS)
- Presystolic accentuation indicates severe MS
- In very severe stenosis (button hole MS), diastolic murmur is often absent due to low flow across MV. Marked tachycardia also dampens MS murmur.

Q7. What are the causes of absence of typical signs of MS?

- Absence of loud S1 due to (a) calcified MV, (b) associated MR
- Absence of presystolic accentuation due to AF
- Absence of diastolic murmur due to tight MS (button hole)
- In the presence of marked clock-wise rotation of heart, MS murmur may not be audible

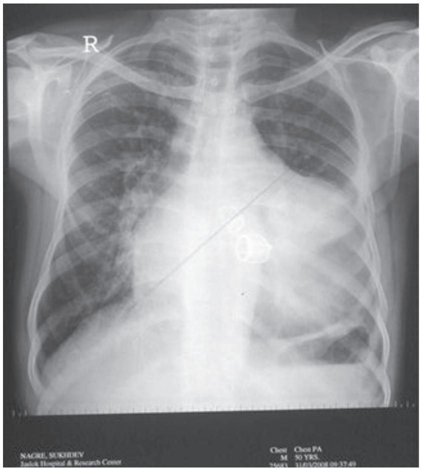
Q8. What are the indications for surgery in MS?

- Left atrial failure (dyspnea)
- Recurrent hemoptysis
- Recurrent systemic embolization

Q9. When would you consider valvuloplasty, valvotomy and valve replacement?

- Balloon valvuloplasty – Isolated MS with mobile valve and absence of LA thrombus. Useful in pregnant women and in patients with poor surgical risk.
- Closed mitral valvotomy – Pure tight MS with pliable valves, orifice less than 1 cm^2.
- Open mitral valvotomy – In pure MS with presence of LA thrombi. Here valve commissures are opened and subvalvular fusion of papillary muscles and chordae tendineae is corrected. Also LA thrombi and calcium deposits are removed.
- Valve replacement – Rigid, calcified valve and/or associated MR.

Biological valves (porcine) or mechanical (Starr-Edwards or Bjork-Shiley or St Jude valve) can be used. Fig. 3.32 shows mitral and aortic prosthetic valves. With mechanical valve replacement life-long anticoagulation is necessary.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Jaslok Hospital & Research Center
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Figure 3.32 Mitral and aortic prosthetic valves.

A case of mitral regurgitation (MR)

1. **Introduction** – Rheumatic heart disease is the commonest cause of MR. It usually coexists with MS and aortic valve disease, particularly AR. Due to incompetent MV, during LV contraction, a proportion of left ventricular blood regurgitates into LA (producing pansystolic murmur in mitral area), raising left atrial and pulmonary venous pressure and in late stages pulmonary arterial pressure. During diastole, there is inflow of this extra blood back into LV causing mid-diastolic flow murmur.
2. **Etiology**
   - **a.** Rheumatic fever
   - **b.** Infective endocarditis
   - **c.** Dilated CMP
   - **d.** Congenital (MVP)
   - **e.** Endocardial cushion defects
   - **f.** Ischemic (papillary muscle dysfunction, rupture)
   - **g.** Connective tissue disorders (Marfan's syndrome, RA, SLE, Ehlers–Danlos syndrome)
   - **h.** Traumatic
   - **i.** Myocarditis
   - **j.** Prosthetic valve mechanical failure
3. **Clinical features (Figs. 3.33 and 3.34)**
4. **Investigations**
   - **a. Electrocardiogram** – Normal in mild cases. In severe cases, LVH (see Chapter 10, Quiz 6), LAH and biventricular hypertrophy are seen in later stages.

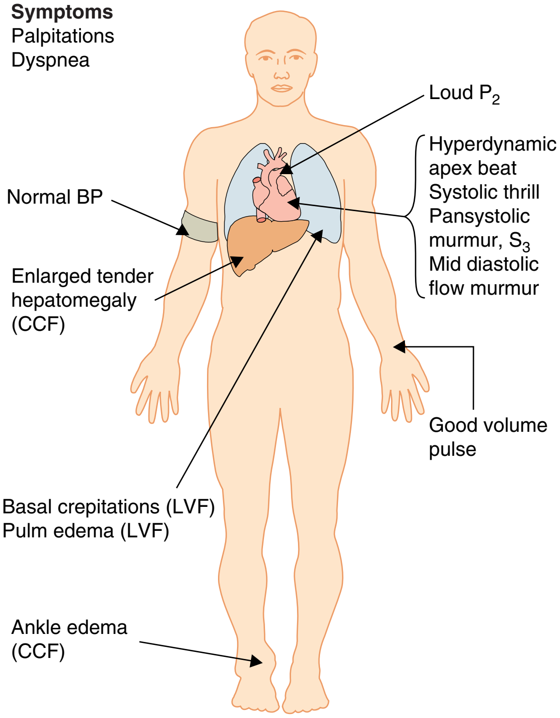
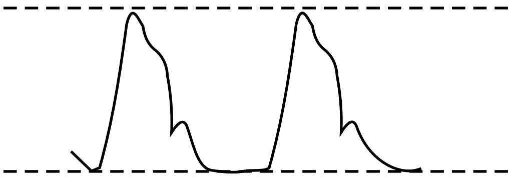
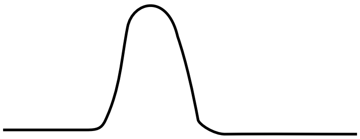

Symptoms
Palpitations
Dyspnea
Loud P_2
Hyperdynamic apex beat
Systolic thrill
Pansystolic murmur, S_3
Mid diastolic flow murmur
Normal BP
Enlarged tender hepatomegaly (CCF)
Good volume pulse
Basal crepitations (LVF)
Pulm edema (LVF)
Ankle edema (CCF)

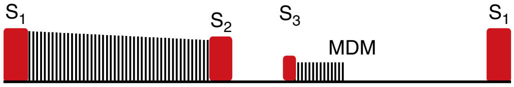
Figure 3.33 Salient clinical features of MR.



Normal or good volume pulse



Hyperdynamic (ill sustained, forcible) apex impulse


S_1
S_2
S_3
S_1
MDM

Auscultatory findings in organic mitral incompetence (high pitched pansystolic murmur, 3rd heart sound followed by short mid diastolic flow murmur).

Figure 3.34 Mitral regurgitation – Important clinical signs.

   - **b. Chest X-ray** – In mild cases, it may be normal. In advanced cases, there is cardiomegaly (LV and LA enlargement). Due to enlargement of left atrial appendage and LA, there is mitralization of left border. Enlarged LA may be seen as double density between two bronchi, causing increase in carinal angle.

   c. **2D echo** – 2D echo assesses severity of mitral incompetence and rules out other causes of MR, e.g. MVP, ruptured chordae tendineae, primary CMP and IE.
   d. **Cardiac catheterization and left ventricular cine-angiography** – It is done to assess MR, and in elderly patients, coronary angiography is done to rule out CAD before valve surgery.

5. **Complications**
   a. Left ventricular failure
   b. Infective endocarditis (higher incidence than MS)
   c. Atrial fibrillation
   d. Left atrial thrombus and systemic embolization (lower incidence than MS)
6. **Differential diagnosis of rheumatic MR** – MVP, CMP. Functional TR, IE Marfan's syndrome, papillary muscle dysfunction or rupture in AMI, connective tissue disorders, (SLE, RA), ruptured chordae tendineae, septum primum defect (ASD), mitral annulus calcification, traumatic (post valvuloplasty).
7. **Management**
   a. **Medical** (Box 3.20)
   b. **Surgical**
      i. Valve replacement or repair – Acute MR needs emergency valve repair or replacement. If due to IHD, patient may need coronary revascularization.
      ii. Indications for surgery
         - Severe MR
         - Left ventricular failure
         - Infective endocarditis

Medical management of MR **Box 3.20**

- Rheumatic fever prophylaxis
- Infective endocarditis prophylaxis
- Treatment of heart failure
- Treatment of AF
- Anticoagulation in presence of left atrial clot

Viva voce

Q1. How do you judge severity of MR?

- Systolic thrill plus pansystolic murmur over mitral area
- Presence of S3 and mid-diastolic flow murmur over mitral area
- Degree of LVH as seen clinically and on ECG and chest X-ray

Q2. What is the DD of pansystolic murmur of MR?

1. **Tricuspid regurgitation** – Heard best over tricuspid area. Murmur accentuates on inspiration and radiates towards right of sternum, pulsatile liver, prominent C-V complexes in JVP.
2. **Ventricular septal defect murmur** – Heard best over left 4th space, accentuates on expiration, radiates towards right side
3. **Papillary muscle dysfunction**
   - Variable duration of murmur
   - Often crescendo–decrescendo murmur
   - May vary from time to time and heard only during an attack of AP
   - Not associated with thrill
4. **Mitral valve prolapse (floppy valve syndrome or Barlow's disease)**
   - Most common cause of isolated MR
   - Myxomatous degeneration of mitral leaflets
   - Posterior leaflet commonly involved, anterior leaflet rarely
   - Common in young females
   - Mid- or late-systolic click followed by late high-pitched systolic murmur which decreases with sitting posture

A case of aortic stenosis (AS)

Classification

   a. Valvular
   b. Subvalvular
   c. Supravalvular

Valvular aortic stenosis

   a. **Etiology**
      i. Rheumatic – Seen in adolescence or adulthood
      ii. Congenital – Seen in childhood, can be supravalvular, valvular or subvalvular, may be associated with bicuspid aortic valve

- **iii.** Calcified AS – Seen in elderly
- **iv.** Aortic sclerosis

Rheumatic AS is usually accompanied by either AR or MV disease.

Clinical features (Figs. 3.35 and 3.36)

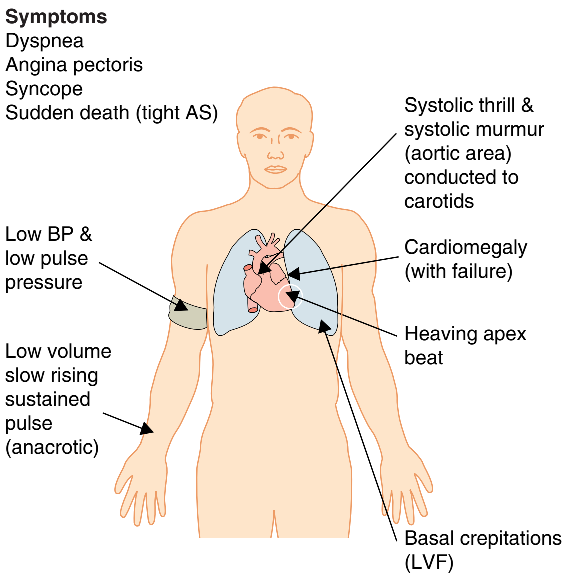
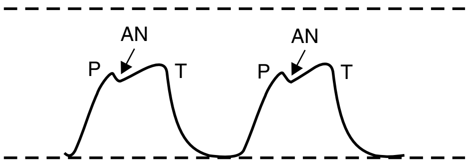
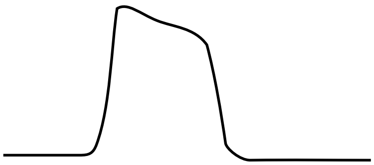

Symptoms
Dyspnea
Angina pectoris
Syncope
Sudden death (tight AS)
Low BP & low pulse pressure
Low volume slow rising sustained pulse (anacrotic)
Systolic thrill & systolic murmur (aortic area) conducted to carotids
Cardiomegaly (with failure)
Heaving apex beat
Basal crepitations (LVF)

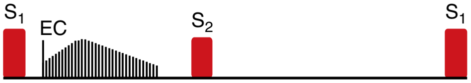
Figure 3.35 Salient clinical features of AS.



anacortic pulse (AN - anacortic notch) (AS)



Heaving (sustained, forcible) apex impulse
Aortic stenosis, hypertension



Auscultatory findings in aortic stenosis (ejection click (EC) followed by mid systolic ejection murmur) and a single S_2 heard over aortic area.

Figure 3.36 Aortic stenosis – important clinical signs.

3. Investigations

a. Electrocardiogram	■ Left ventricular hypertrophy with strain pattern, LBBB, complete heart block
b. Chest X-ray	■ Rounded apex ■ Heart enlarged when dilated and with failure ■ Poststenotic dilatation of AA ■ Calcified aortic valve (especially in elderly)
c. 2D echo	■ Left ventricular hypertrophy, calcified A valve, gradient measurement to assess severity
d. Cardiac catheterization	■ To estimate gradient across aortic valve and detect AR if present
e. Coronary angiography	■ To detect CAD before surgery

4. Complications

- **a.** Left ventricular failure – Rapidly progressive
- **b.** Right ventricular failure – End-stage-indicates poor prognosis
- **c.** Sudden death due to arrhythmias (ventricular fibrillation)
- **d.** Complete heart block (extension of aortic valve calcification to AV node)
- **e.** Infective endocarditis
- **f.** Hemolysis
- **g.** Aortic dissection

5. Management

- **a. Medical**
  - **i.** Treatment of LVF
  - **ii.** Rheumatic fever and IE prophylaxis
  - **iii.** Beta-blockers to reduce heart rate, improve coronary artery blood flow in patients with IHD
  - **iv.** Statins for AS due to aortic sclerosis
- **b. Surgical**
  - **i.** Balloon aortic commissurotomy or open heart aortic valve commissurotomy
  - **ii.** If associated with AI, aortic valve replacement
  - **iii.** If associated with MS, both aortic valve and MVs should be operated simultaneously

iv. Indications of balloon valvotomy
- Mainly in children and very young adults with congenital AS
- In elderly unfit for surgery
- As a temporary measure in unstable patients

Viva voce

Q1. What is aortic sclerosis?

In elderly persons with atherosclerosis, there is fibrosis and calcification of aortic valve cusps. This presents with harsh, ejection systolic murmur over aortic area conducted to carotid vessels. In some cases, calcification becomes more significant resulting in aortic valve stenosis (calcific AS). Chest X-ray shows calcification of aortic valve and aortic knuckle. Presentation is like AS. One may find evidence of atherosclerosis, e.g. atherosclerotic peripheral vascular disease.

Q2. How will you assess severity of AS?

1. **Auscultation**
   - Murmur – Longer the murmur and later the peaking of murmur, more severe is the AS
   - A2 followed by P2 (mild AS), delayed A2 – merging with P2 single S2 (moderate AS), A2 following P2-reverse splitting (severe AS)
   - S4 audible and absent A2 – severe AS
   - S3 audible-severe systolic dysfunction, LVF
2. **Gradient across aortic area**
   - Mild – Less than 30 mm Hg
   - Moderate – 30–50 mm Hg
   - Severe – Greater than 50 mm Hg
3. **Measurement of aortic valve area**
   - Normal aortic valve area – 3–4 cm^2/m^2 body surface area
   - Mild AS – 1–2 cm^2/m^2 body surface area
   - Severe AS – Less than 0.75 cm^2/m^2 body surface area
   - Critical AS – Less than 0.5 cm^2/m^2 body surface area

Q3. What is the DD of systolic murmur in aortic area?

- Functional in severe AR
- Sclerotic aortic valve
- Coarctation of aorta
- Ventricular septal defect (transmitted) murmur
- Mitral regurgitation murmur transmitted to base of heart
- Syphilitic aortitis
- Supravalvular AS
- Subvalvular intrinsic hypertrophic aortic stenosis (systolic murmur heard better over 2nd aortic area – Erb's area)

Q4. What is Bernheim effect?

Bulging of interventricular septum in the RV due to LVH causing features of right heart failure.

A case of aortic regurgitation (AR)

1. **Etiology** (Table 3.3)
2. **Hemodynamic alterations** – Due to incompetent aortic valve which does not close after LV systole, there is leakage of blood from aorta to LV causing volume overload of LV. Left ventricular dilatation results in dilatation of MV ring leading to functional MR. The MV cusps are normal. The end result is left ventricular dilatation, hypertrophy and LV dysfunction with failure.
3. **Clinical features** (**Figs.** 3.37 and 3.38; **Box** 3.21)
4. **Investigations**
   - **a. Electrocardiogram** – LVH (see Fig. 10.30). Left atrial enlargement may be present.
   - **b. Chest X-ray**
     - **i.** Cardiomegaly (outward and downward enlargement of LV), ascending aorta and aortic arch dilatation.
     - **ii.** In elderly patients, calcification of aortic valves may be seen

Table 3.3 Etiological causes of AR

Aortic valve disease	Aortic disease
Rheumatic	Syphilitic aortitis
Congenital (bicuspid valve)	Marfan's syndrome
Infective endocarditis	Rheumatoid arthritis
Trauma (rupture of aortic valve)	Ankylosing spondylitis
	Hypertension
	Aortic dissection
	Rupture of sinus of Valsalva
	Takayasu's arteritis
	Mucopolysaccharidosis – Hurler's syndrome
	Ehlers–Danlos syndrome

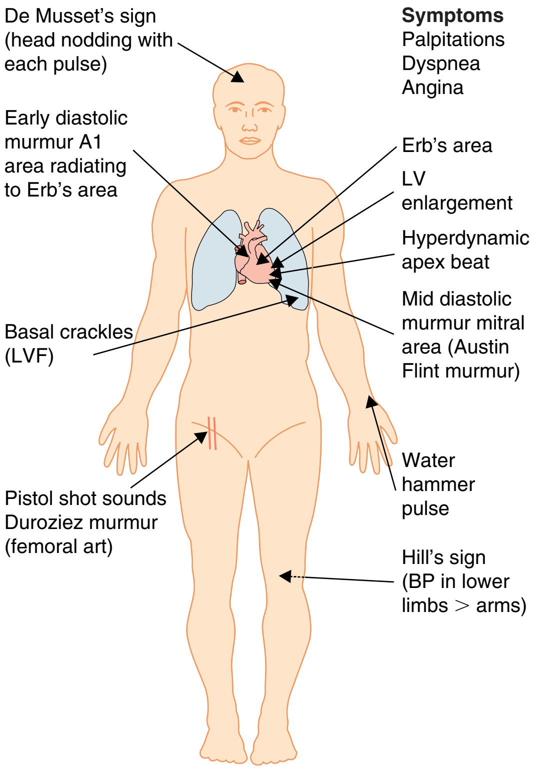
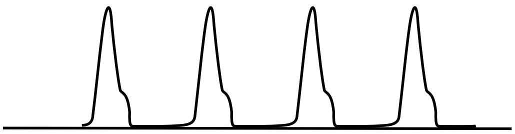
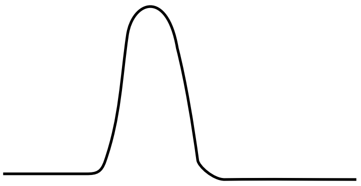

De Musset's sign (head nodding with each pulse)
Symptoms
Palpitations
Dyspnea
Angina
Early diastolic murmur A1 area radiating to Erb's area
Erb's area
LV enlargement
Hyperdynamic apex beat
Mid diastolic murmur mitral area (Austin Flint murmur)
Basal crackles (LVF)
Water hammer pulse
Pistol shot sounds Duroziez murmur (femoral art)
Hill's sign (BP in lower limbs > arms)

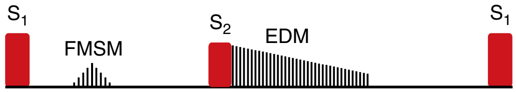
Figure 3.37 Salient clinical features of AR.



Water-hammer pulse (Corrigan's pulse)



Hyperdynamic (ill sustained, forcible) apex impulse


S_1
FMSM
S_2
EDM
S_1

Auscultatory findings in aortic incompetence (early decresendo diastolic murmur) heard best over second aortic area and along sternal border. Functional mid systolic murmur (FMSM) may be heard.

Figure 3.38 Aortic regurgitation – important clinical signs.

Peripheral arterial signs of AR **Box 3.21**

- Large volume pulse (water hammer character) (Fig. 3.6)
- Due to wide pulse pressure, one can get several peripheral arterial or capillary signs, e.g. Corrigan's sign (dancing carotids), de Musset's sign (to-and-fro shaking of head), Quincke's sign (blanching and flushing of the capillaries in nail bed or over lips with gentle compression by glass side), Muller's sign (pulsations in the uvula), Becker's sign (retinal artery pulsation)
- High SBP, low DBP, high pulse pressure
- Systolic blood pressure in legs (popliteal) 20–40 mm higher than BP in arms (Hill's sign)
- Pistol shot sounds over femoral arteries (Traube's sign). One can hear systolic and diastolic bruit over femoral artery by mild compression of chest piece of stethoscope (Duroziez murmur)

        - **iii.** Calcification of ascending aorta in syphilitic AR, Marfan's syndrome and aortic dissection
    - **c.** **2D echo** – Gives information regarding aortic root size, annular dimension, aortic cusps and aortic valve vegetations if present. Color Doppler assesses the severity of AI.
    - **d.** **Coronary angiography** – In elderly patients with suspected CAD, coronary angiography done to assess the severity of CAD.

5. **Complications**
    - **a.** Left ventricular failure
    - **b.** Congestive cardiac failure
    - **c.** Infective endocarditis
6. **Differential diagnosis (etiological)** – Rheumatic, syphilitic, Marfan's syndrome, congenital.
7. **Management**
    - **a.** **Medical**
        - **i.** Rheumatic fever and IE prophylaxis
        - **ii.** Treatment of LVF
        - **iii.** Treatment of complications, particularly IE
    - **b.** **Surgical** – For symptomatic patients
      Valve replacement (prosthetic or tissue valve)

Viva voce

Q1. How will you assess severity of AR?

- Longer the EDM (greater than 2/3 of diastole), more severe the AR
- Hill's sign – When popliteal SBP exceeds brachial SBP by more than 60 mm Hg
- Presence of Austin Flint murmur (p-78)
- Marked peripheral signs

Q2. How will you classify LVH?

1. **Concentric** – LV muscle mass is hypertrophic due to pressure overload. Dilatation may occur in late stage when LVF sets in.
   a. Causes
      i. Aortic stenosis
      ii. Hypertension
      iii. Hypertrophic obstructive cardiomyopathy
      iv. Coarctation of aorta
2. **Eccentric** – In addition to increase in muscle mass, there is significant LV dilatation due to volume overload.
   a. Causes
      i. MR, AR
      ii. Severe anemia
      iii. Thyrotoxicosis
      iv. Ventricular septal defect, PDA
      v. Ischemic CMP
      vi. Dilated CMP

Q3. How will you differentiate between EDM of AR and PR? (Table 3.4)

Table 3.4 Differences between EDM murmurs of AR and PR

AR	PR
Murmur heard over aortic 1 area radiating along left sternal border to 3rd and 4th ICSs and best heard over Erb's area (aortic II area). Murmur of longer duration starting with A2	Murmur heard over pulmonary area radiating down along left sternal border, murmur is of short duration starting with loud P2
Best heard in expiratory apnea	Best heard in inspiration
Murmur enhanced with hand grip and phenylephrine infusion	Murmur decreased with hand grip and phenylephrine infusion

Q4. How will you differentiate between rheumatic and syphilitic AR? (Table 3.5)

Table 3.5 Differences between rheumatic and syphilitic AR

	Rheumatic AR	Syphilitic AR
1. Past history of	Rheumatic fever	Syphilis
2. Sex	Either sex	M > F
3. Angina	+/−	+, atypical – burning, prolonged. Pain may not be induced by exertion
4. S2	N/diminished	Loud tambour like
5. Severity of AR	Mild to moderate	Severe
6. Murmur best heard at	Left 3rd ICS parasternal plane (Erb's area)	Right 2nd ICS parasternal plane
7. Transmission	Along left parasternal plane	Along right parasternal plane
8. Associated MV disease	Common	Not associated
9. Erythrocyte sedimentation rate	N	Increased
10. Veneral disease research laboratory (VDRL)	−ve	+ve
11. X-ray	Aortic valve calcification	AA calcification

Q5. Enumerate causes of high-output cardiac failure?

- Severe anemia
- Hyperthyroidism
- Aortic regurgitation
- Patent ductus arteriosus
- Arteriovenous fistula
- Paget's disease
- Beriberi

A case of mitral stenosis and mitral incompetence

This is invariably organic and of rheumatic etiology. The findings will depend upon the dominance of one lesion over other lesion: MS > MR or MR > MS or both are balanced. The type of pulse and apex beat will vary accordingly.

In a patient with dominant MR, findings would be good volume or normal volume pulse, normal BP, apex beat hyperdynamic shifted down and out 6th ICS outside midclavicular line, systolic thrill over mitral area, left border of heart displaced laterally, mild RV heave (+), soft S1, pansystolic murmur conducted to axilla (MR) and mid-diastolic rumble murmur (MS) without presystolic accentuation, OS (±); P2 accentuated (PHT).

In a patient with dominant MS, findings would be low volume pulse, low SBP with narrow pulse pressure, tapping apex beat in left 5th ICS outside midclavicular line, predominant diastolic thrill, left parasternal heave (RV ++), S1 loud, OS audible followed by mid-diastolic rumble murmur with presystolic accentuation, systolic murmur audible but not classical pansystolic, P2 accentuated (PHT).

Similarly, chest X-ray and ECG will reflect the dominance. With MR > MS, chest X-ray (Fig. 3.39) will show predominant LVH along with LAH, and ECG will show predominant LVH with P-mitrale and with MS > MR, chest X-ray will show predominant RVH + LAH (Fig. 3.40) and ECG will show predominant RVH with P-mitrale.

1. **Management** – It includes mainly the management of complications like CCF, AF and IE. Also one should carry on rheumatic and IE prophylaxis. For cure, MV prosthesis.

A case of aortic stenosis and aortic regurgitation

Combined AS and AR is usually of rheumatic etiology and usually organic.

The findings will depend on dominance of AS over AR or vice versa.

Salient features of AS > AR are pulsus bisferiens (prominent tidal wave), low systolic or normal BP with minimal peripheral arterial signs, apex beat heaving (LV type), systolic thrill over aortic area and carotids, ejection click followed by ejection systolic murmur over aortic area conducted to carotids and EDM over aortic I and better heard over aortic II (Erb's area).

The salient features of a case of AR > AS are water hammer or bisferiens pulse, high systolic and low DBP, peripheral signs of AR, apex beat hyperdynamic displaced down and out, systolic thrill over aortic area and carotids, ejection systolic murmur over aortic area conducted to carotids and EDM typical of AR heard best over Erb's area.

1. **Investigations**
   a. Chest X-ray – Cardiomegaly in both types of cases but in AR > AS, heart enlargement is significant as there is LV dilatation

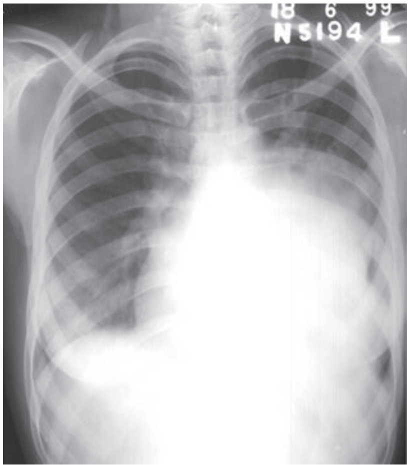


Figure 3.39 Mitral regurgitation with MS (with predominant MR).

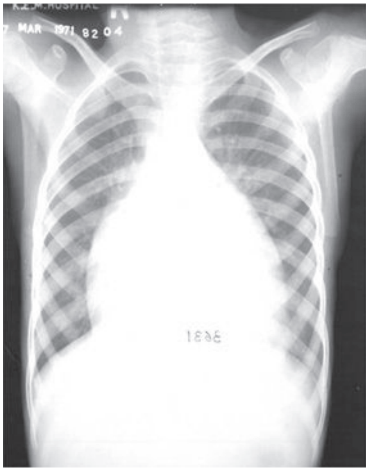


Figure 3.40 Mitral stenosis with MI (with predominant MS).

in addition to LVH, whereas in AS > AR, there is mainly concentric LVH.

   b. Electrocardiogram will show LVH in both types
   c. 2D echo – It can clearly differentiate the dominance of AS or AR in combined lesions.

2. **Management** – Treat complications like CCF and IE. For cure, prosthetic valve replacement.

A case of mitral stenosis and aortic regurgitation

Combined MS and AI is almost always of rheumatic etiology. The clinical findings will depend upon the dominance of one lesion over other: MS > AI or AI > MS or both are balanced. The type of pulse, apex beat and peripheral signs will vary accordingly.

In dominant MS, a patient will have good volume or normal volume pulse but not water hammer pulse. Blood pressure would be normal with normal pulse pressure. Peripheral signs are usually absent. Apex beat is normal and displaced laterally, and diastolic thrill is palpable over mitral area, RV pulsations may be present, P2 may be palpable. On percussion, there is cardiomegaly. On auscultation, there will be OS, MDM of MS and loud SI in mitral area and EDM of AR over aortic I and aortic II (Erb's) areas.

In dominant AR, a patient will have high volume pulse with good peripheral signs. Apex beat is displaced down and cut and is hyperdynamic type. Diastolic thrill of MS may be present, but RV pulsations and palpable P2 are not significant. Percussion will reveal cardiomegaly. On auscultation, MDM audible but OS and loud snappy S1 may be absent. Early diastolic murmur of AR is clearly heard over aortic I area and conducted to Erb's area.

1. **Investigations**
   a. Chest X-ray – Cardiomegaly enlarged LV in both types, LA enlarged more in predominant MS case.
   b. Electrocardiogram – LVH in both cases. P-mitrale in a case having predominant MS
   c. 2D echo – Will not only help in diagnosis of both lesions (MS and AI) but will also determine the relative dominance of one lesion over the other lesion.
2. **Treatment**
   a. Medical – For complications such as CCF, IE.
   b. Surgical – Mitral valvuloplasty and aortic valve replacement by prosthesis

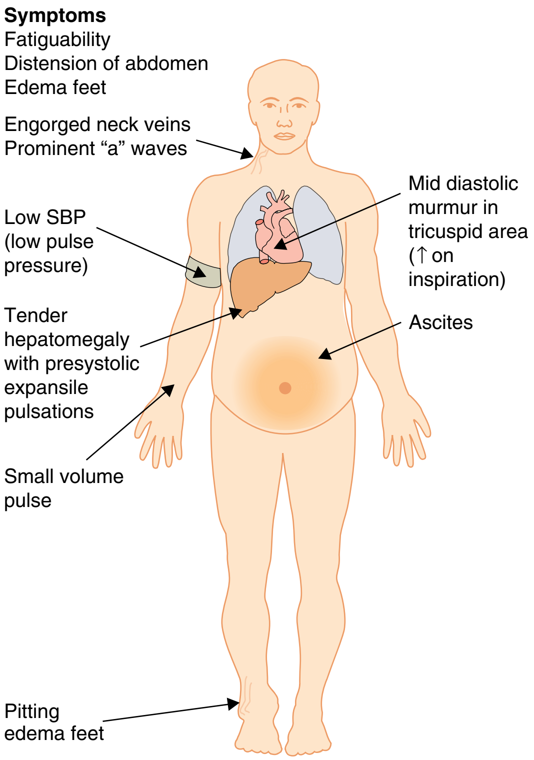

Symptoms
Fatiguability
Distension of abdomen
Edema feet
Engorged neck veins
Prominent "a" waves
Mid diastolic murmur in tricuspid area (↑ on inspiration)
Low SBP (low pulse pressure)
Tender hepatomegaly with presystolic expansile pulsations
Ascites
Small volume pulse
Pitting edema feet

Figure 3.41 Salient clinical features of TS.

A case of tricuspid stenosis

1. **Introduction**
   a. Rare valvular affection
   b. Occurs invariably along with MV disease and/or with aortic valve disease
   c. There is increase in right atrial pressure and JVP due to obstruction to flow from right atrium to RV
2. **Etiology**
   a. Rheumatic
   b. Congenital
   c. Carcinoid syndrome
   d. Right atrial myxoma may mimic TS
3. **Clinical features (Fig. 3.41)**
4. **Investigations**
   a. **Electrocardiogram** – Tall P wave (P-pulmonale). In some cases, AF may be present. No evidence of RVH.
   b. **Chest X-ray** – Right atrial dilatation (RAD) with prominent SVC.
5. **Differences between MS and TS (Box 3.22)**
6. **Management**
   a. **Medical**
      Antifailure treatment

Differential features between MS and TS — Box 3.22

Murmur	MS	TS
▪ Site	Best heard at apex in left lateral position	Heard best over 5th ICS at right and left parasternal borders in right lateral position
▪ Character	Rumbling mid-diastolic with presystolic accentuation	Scratchy, crescendo–decrescendo PSM
▪ Duration	Long	Short
▪ Effect of breathing	Increased with expiration	Increased with inspiration
▪ Prominent 'a' waves	Not present	Present with presystolic hepatic pulsations
▪ Electrocardiogram	Left atrial enlargement	Right atrial enlargement
▪ 2D echo	Helps to differentiate the two	Tricuspid stenosis may, however, be present along with MS in some patients

   b. **Surgical**
      i. Percutaneous tricuspid valvuloplasty, valve repair or valve replacement.
      ii. Simultaneous correction of associated MS.

A case of tricuspid regurgitation

1. **Introduction** – Organic rheumatic TR is very rare. However, functional TR secondary to PHT as a result of rheumatic MV disease is more frequently seen.
2. **Hemodynamics** – In TR, there is volume overload of RV and raised right atrial pressure with prominent CV waves (Fig. 3.11).
3. **Clinical features** (Fig. 3.42)

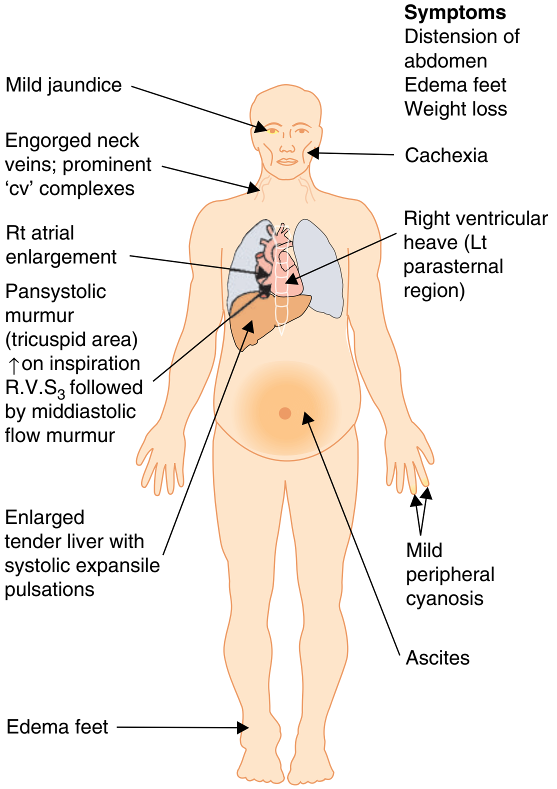

Symptoms
Distension of abdomen
Edema feet
Weight loss
Mild jaundice
Cachexia
Engorged neck veins; prominent 'cv' complexes
Rt atrial enlargement
Right ventricular heave (Lt parasternal region)
Pansystolic murmur (tricuspid area) ↑on inspiration R.V.S_3 followed by middiastolic flow murmur
Mild peripheral cyanosis
Enlarged tender liver with systolic expansile pulsations
Ascites
Edema feet

Figure 3.42 Salient clinical features of TR.

4. **Investigations**
   a. **Electrocardiogram** – There is right axis deviation, RVH, incomplete RBBB, bi-atrial enlargement (in presence of left heart disease).
   b. **Chest X-ray** – Cardiomegaly due to bi-atrial and bi-ventricular enlargements (in presence of left heart disease). Superior vena cava is dilated.
5. **Management** – Tricuspid regurgitation is usually a benign (functional) disorder and does not require treatment.
   a. **Medical** – Treat as CCF with digitalis and diuretics.
   b. **Surgical** – Only for organic TR, valve replacement.

A case of infective endocarditis

1. **Introduction** – IE is an infection of endocardium, usually bacterial but can be fungal also. Infective endocarditis is the result of two factors: a structural cardiac defect (valvular or nonvalvular) and bacteremia. Prosthetic valves are particularly susceptible to infection. Exceptions are MS and ASD in which IE is a rare complication. Infective endocarditis is more common on left side. Right-side endocarditis is more likely in intravenous drug users.
2. **Sources of organism** – Oral cavity (dental treatment), urinary tract infection, cutaneous

abscess, shunts, central venous catheters, prosthetic devices; history of dental treatment or genitourinary instrumentation should be elicited.

   a. Common organisms – *Streptococci viridans, Staphylococcus aureus*.
   b. Others – *Enterococci*, gram-negative bacilli, HACEK organisms, fungi

3. **Clinical features** – Important clinical features are fever with chills, fatigability, weight loss, arthralgias, clubbing (Fig. 3.43). (In addition, remember 'five Ps': pyrexia, pallor, petechiae, palpable spleen, positive blood culture.)

   Right-sided endocarditis – Cough, pleuritis, chest pain, hemoptysis, recurrent lung lesions.

4. **Investigations** – (1) Leukocytosis, (2) anemia, (3) microscopic hematuria, (4) raised ESR and CRP, (5) positive blood culture, (6) bone marrow culture helpful in culture-negative cases, (7) serological study for *Candida, Histoplasma* and *Brucella* helpful in culture-negative cases, (8) chest X-ray – cardiomegaly, (9) ECG – tachycardia, changes of chamber enlargement according to the valvular lesion and (10) 2D echo (including transesophageal echocardiography [TEE]) clinches the diagnosis when vegetations/abscess are seen.

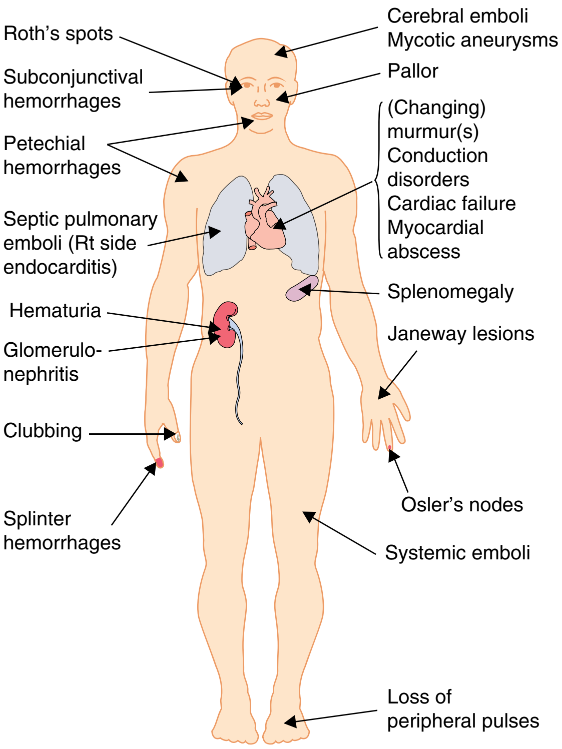

Roth's spots
Subconjunctival hemorrhages
Petechial hemorrhages
Septic pulmonary emboli (Rt side endocarditis)
Hematuria
Glomerulo-nephritis
Clubbing
Splinter hemorrhages
Cerebral emboli
Mycotic aneurysms
Pallor
(Changing) murmur(s)
Conduction disorders
Cardiac failure
Myocardial abscess
Splenomegaly
Janeway lesions
Osler's nodes
Systemic emboli
Loss of peripheral pulses

Figure 3.43 Clinical features of IE.

5. **Complications**
   a. Local – Valve destruction, myocardial abscess, conduction disturbances due to septal abscess and aortitis.
   b. Systemic – Embolization
      i. Right sided – Pulmonary infarction, recurrent pneumonia, empyema
      ii. Left sided – Kidney, spleen, CNS, cutaneous and retinal emboli (common)

Viva voce

Q1. Describe right-sided endocarditis?

- Common in drug addicts
- *Staphylococcus aureus* is the commonest infecting organism
- Affects mainly tricuspid valve
- Pulmonary emboli

Q2. What are the causes of culture-negative IE?

- Intermittent bacteremia
- Partially treated patients
- Fungal, yeast infection, HACEK organisms, fastidious organisms (need prolonged culture)
- Libman–Sacks endocarditis (non-IE)
- Right-sided endocarditis

Q3. Which cases of IE carry poor prognosis?

- Presence of CCF
- Prosthetic valve endocarditis
- Gram-negative or fungal endocarditis
- Aortic or more than one valve involvement
- Culture-negative endocarditis
- Elderly
- Major embolic events
- Mycotic aneurysm
- Large vegetations

Q4. What is Marantic endocarditis?

Seen in patients with chronic wasting diseases (disseminated mucin-producing metastatic carcinoma, chronic infections). Vegetations are large with embolization. It involves damaged valves or congenital heart defects. Anticoagulation is often indicated.

Q5. In which conditions you get changing heart murmurs?

- Atrial myxoma
- Atrial ball valve thrombus
- Infective endocarditis

Q6. What does 'Seagull' or cooing dove murmur signify?

This murmur is of musical (resonating) quality and is generally heard when there is rupture of chordae tendineae which occurs in IE and AMI.

A case of systemic hypertension

Usually a case of essential HT alone is not kept for practicals, but one may see HT as a comorbid condition along with other system disease. Hence, useful practical points regarding HT are given below.

1. **Prevalence** – No well-studied national surveys. Varying reports from small surveys. Rural areas 2.5–3.5%, urban areas 4–18% and slum populations 7.5%.
2. **Classification**

VII JNC classification	SBP (mm Hg)	DBP (mm Hg)
Normal	<120	<80
Prehypertension	130–139	85–89
Hypertension	≥140	≥90
Stage 1	140–159	90–99
Stage 2	160–179	100–109
Stage 3	≥180	≥110

3. **Types**

Essential (1°) 93–94%, secondary (2°) 6–7%

Hypertension

1. **Clinical examination** (Fig. 3.44)
2. **Investigations**
   a. Electrocardiogram – LVH and/or strain
   b. Chest X-ray – LVH. In presence of LVF, pulmonary venous congestion/pulmonary edema.
3. **Complications**
   a. Hypertensive encephalopathy, transient ischemic attacks or stroke
   b. Acute myocardial infarction, AP, LVF, CRF, visual loss
   c. Peripheral vascular disease
   d. Sudden death
   e. Aortic dissection
   f. Hypertensive retinopathy

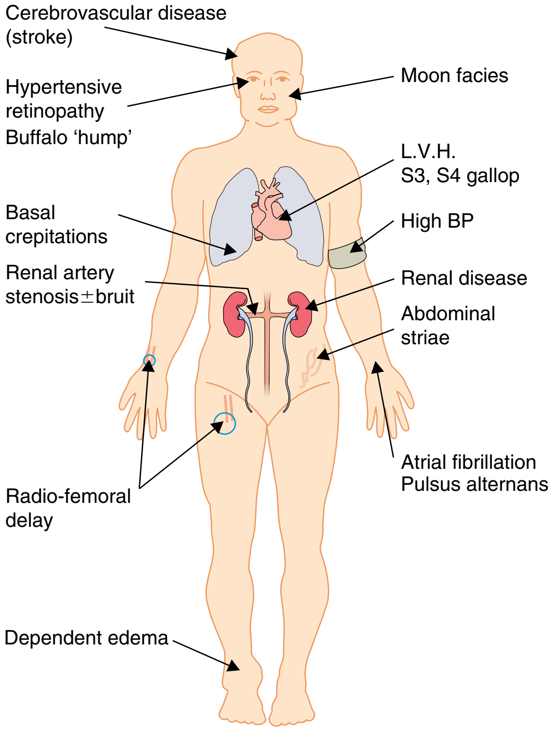

Cerebrovascular disease (stroke)
Moon facies
Hypertensive retinopathy
Buffalo 'hump'
L.V.H.
S3, S4 gallop
Basal crepitations
High BP
Renal artery stenosis±bruit
Renal disease
Abdominal striae
Atrial fibrillation
Pulsus alternans
Radio-femoral delay
Dependent edema

Figure 3.44 Hypertension – Clinical examination.

Keith and Wagner's grading of hypertensive retinopathy
Grade I – 'Silver wire' appearance of arteries due to tortuosity and thickening
Grade II – Grade 1 changes plus arteriovenous nipping
Grade III – Grade 2 changes plus superficial flame-shaped hemorrhages and cotton wool exudates (Fig. 3.45)

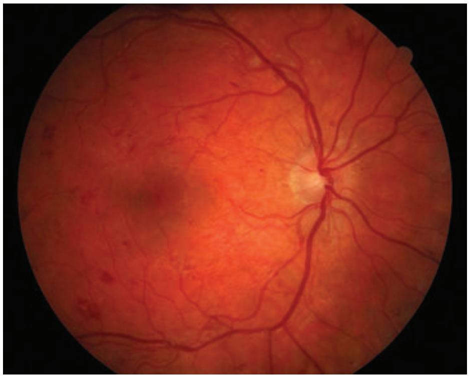


Figure 3.45 Hypertension – Grade III retinopathy (arteriovenous nipping, cotton wool exudates, flame hemorrhages).

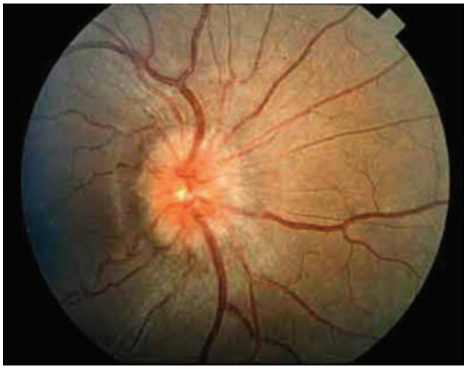


Figure 3.46 Hypertension – Papilledema.

Grade IV – Grade 3 changes plus papilledema (Fig. 3.46)

4. **Management principles of HT**
    - a. All patients of HT must be treated. Aim at BP lesser than or equal to 120/80 mm Hg.
    - b. Nondrug therapy for all patients
    - c. Drug therapy in all higher grades of HT and in mild grades when nondrug therapy fails
    - d. Drug therapy is a must in the presence of target organ damage and with comorbid conditions
    - e. In mild cases, monotherapy may be enough, but in higher grades of HT, combination therapy is necessary. Choose drugs with 24 hours of action.
5. **For special situations, preferred drugs are**
    - a. Hypertension with CCF – Diuretics, ACE inhibitors
    - b. Hypertension with DM – ACE inhibitors or angiotensin-receptor blockers (ARBs)
    - c. Hypertension with chronic renal disease – ACE inhibitors, ARBs
    - d. Hypertension with myocardial infarction – Beta-blockers, ACE inhibitors
    - e. Isolated SBP – Diuretics, long-acting calcium channel blockers.

A case of secondary hypertension

1. **Causes**
    - a. **Renal (4% overall)** – The most common cause of 2° HT
        - i. Renovascular
        - ii. Parenchymal renal diseases
    - b. **Endocrine disorders (1–2%) (see Chapter 8)**
        - i. Pheochromocytoma
        - ii. Primary aldosteronism
        - iii. Cushing's syndrome
        - iv. Hypothyroidism
        - v. Hyperthyroidism
        - vi. Acromegaly
    - c. **Miscellaneous (1%)**
        - i. Coarctation of aorta
        - ii. Drugs (steroids, oral contraceptives, sympathomimetics [e.g. nasal drops])
        - iii. Polyarteritis nodosa, polycythemia vera rubra, acute intermittent porphyria.

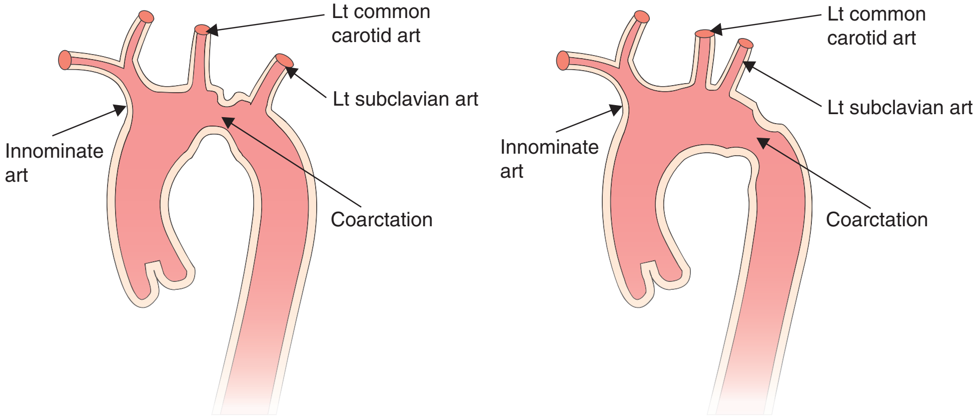
Renovascular HT

1. **Causes**
    - a. Atherosclerotic renal artery stenosis (elderly)
    - b. Fibromuscular dysplasia (younger patients)
    - c. Aortoarteritis (younger patients) – commonest cause in Indians
2. **Clinical features** – Severe HT (recent onset), abdominal bruit (systolic plus diastolic), Grade 3 and 4 retinopathy, often resistant to drug therapy

Note – Suspect renovascular HT in HT of young or of late onset.

The renal artery stenosis has to be more than 70% to be hemodynamically significant.

3. **Investigations** – Renal Doppler, renal arteriography (conventional digital subtraction angiography or MR angiography), radionuclide captopril angiography, and plasma renin estimation.
4. **Management**
    - a. **Medical**
        - i. Beta-blockers
        - ii. Angiotensin-converting enzyme inhibitors or ARBs (contraindications – solitary kidney or bilateral renal artery stenosis). Monitor renal function.
    - b. **Surgical**
        - i. Stenting
        - ii. Aortorenal artery bypass (venous or arterial graft)


Lt common carotid art
Lt subclavian art
Innominate art
Coarctation
Lt common carotid art
Lt subclavian art
Innominate art
Coarctation

Pre-subclavian coarctation

Post-subclavian coarctation

Figure 3.47 Coarctation of aorta.

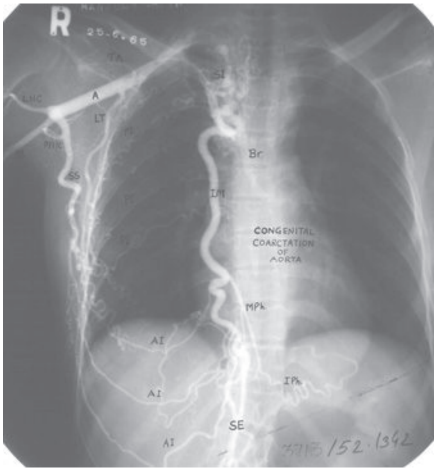
Renal HT – Parenchymal renal diseases

Chronic glomerulonephritis, chronic pyelonephritis, diabetic nephropathy, polycystic kidney disease, acute glomerulonephritis (transient HT), vasculitis, analgesic nephropathy, renal stones with obstructive uropathy, hypernephroma, renal transplant patients.

1. Management
   - **a.** Beta-blockers
   - **b.** Alpha-blockers
   - **c.** Hydralazine
   - **d.** Loop diuretics

A case of coarctation of aorta

1. Causes
   - **a.** Congenital
   - **b.** Acquired – aorto arteritis (Takayasu's arteritis)
2. **Clinical features of congenital coarctation of aorto (presubclavian and postsubclavian) (Fig. 3.47)**
   - **a.** Accounts for 8–10% of congenital heart diseases.
   - **b.** There is narrowing beyond the origin of left subclavian artery at the insertion of PDA, or rarely over abdominal aorta. May be isolated or accompany other congenital anomalies (VSD, PDA, AS). Berry aneurysms in circle of Willis may be present. It may be part of Turner's syndrome.
   - **c.** There is HT in upper extremities with normal or low pressure in lower limbs. Hypertension is due to renal hypoperfusion. Femoral pulse is weak or delayed compared with radial pulse. In presubclavian coarctation, left radial pulse is weak.
   - **d.** Pulsatile carotids, forcible apex beat, cardiomegaly (LV+), an ejection click and ejection systolic murmur over aortic area and left upper interscapular area, S4 audible in severe HT. One may feel pulsations and hear continuous murmur on upper back over the anastomosing collateral vessels (Fig. 3.48) (Suzman's sign). There is poor development of lower limbs compared with upper limbs.
   - **e.** Fundus – Corkscrew appearance of retinal arteries.


R
25.6.65
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CONGENITAL COARCTATION OF AORTA
MPh
AI
AI
AI
IPh
SE

Figure 3.48 Congenital coarctation with anastomosing collateral vessels.

3. **Investigations**
   a. Electrocardiogram – LVH.
   b. Chest X-ray – Normal heart size or mild cardiomegaly (LVH), prominent AA and aortic knuckle, rib notching (usually 3rd to 8th ribs) (Fig. 3.49). Barium-filled esophagus shows indentation by dilated arch of aorta and poststenotic dilatation (figure of 3 sign).
   c. 2D echo – LVH – one may detect bicuspid aortic valve.
   d. Cine-magnetic resonance imaging – Useful to locate narrowing and flow across the coarctation.
   e. Cine-angiography visualizes the coarctation.
4. **Management**
   a. Medical – Control of HT, CCF, IE prophylaxis
   b. Definitive – Balloon dilatation preferred to surgery
   c. Surgery if balloon angioplasty not possible

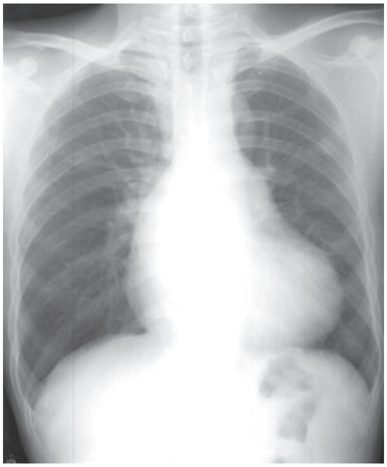

Figure 3.49 Coarctation of aorta – LVH, prominent ascending aorta and aortic knuckle, rib notching.

Viva voce

Q1. How will you prognosticate a case of HT?

Factors indicating poor prognosis

- Higher grade of HT
- Advancing age (men older than 50 years, women older than 60 years)
- Smoking, alcohol consumption, obesity, sedentary lifestyle
- Associated diabetes mellitus or impaired glucose tolerance
- Dyslipidemia (↑ LDL, ↓ HDL)
- Microalbuminuria
- Dissecting aneurysm
- Target organ damage –
  Left ventricular hypertrophy, LVF, ischemic heart disease, cerebrovascular disease, peripheral vascular disease, nephropathy, renal failure, severe hypertensive retinopathy

Q2. When will you suspect 2° HT?

Young patient, severe grade HT (accelerated HT), refractory HT, no history of HT in family, labile HT.

Q3. What are the key clues to different causes of 2° HT?

- Renovascular – Bruit over renal artery
- Parenchymal renal disease – Albuminuria
- Coarctation of aorta – Radiofemoral delay and low volume femorals
- Pheochromocytoma – Paroxysmal, labile HT with palpitations, sweating
- Cushing's syndrome – Truncal obesity with thin limbs, purple stria over abdomen.

Q4. What are the causes of accelerated HT? (Box 3.23)

Causes of accelerated HT **Box 3.23**

- Essential HT
- Rapidly progressive glomerulonephritis
- Renovascular HT
- Hypertension during pregnancy
- Pheochromocytoma
- Rapid withdrawal of drugs (e.g. clonidine)
- Drug interaction with mono amine oxidase inhibitors
- Polyarteritis nodosa
- Scleroderma (crisis)

Note – Avoid using term *malignant HT* as with newer drugs, one can control severe grades of HT. Hence, 'accelerated' is appropriate term.

Q5. What are the causes of isolated systolic HT?

In old age aortic atherosclerosis is the commonest and important cause of SBP.

Severe anemia, hyperthyroidism, AR, PDA, arteriovenous fistula and complete heart block are other causes.

Q6. What investigations would you do to determine the cause of secondary HT?

1. For renal or renovascular HT (commonest cause of secondary HT in India)
   - 24 hours urinary albumin
   - Microalbuminuria
   - Ultrasound of abdomen (kidney, ureter and bladder), intravenous pyelography
   - Plasma renin levels
   - Renal arteriography, magnetic resonance angiography, CT angiography
   - Captopril radionuclide renography
   - Kidney biopsy.
2. Coarctation of aorta or aortoarteritis – Aortography.
3. Pheochromocytoma – 24 hours urine for catecholamines and vanillylmandelic acid, plasma catecholamines and CT scan of abdomen.
4. For Conn's syndrome, plasma aldosterone levels and CT scan of abdomen to detect tumor.
5. For Cushing's syndrome, plasma cortisol levels and dexamethasone suppression test.

Q7. How will you evaluate a young man of 30 years with a BP of 220/140 mm Hg?

- Clinical examination which includes examination for target organ involvement (eyes, heart, kidney and brain)
- Routine urine examination (albumin, RBC, casts, sugar)
- Electrocardiogram for LVH
- Chest X-ray for LVH, LVF, features of coarctation of aorta
- 2D echo for LVH
- Blood sugar (fasting and postprandial blood sugar) and glycosylated hemoglobin (Hb)
- Lipid profile
- Serum creatinine, blood urea, electrolytes, bicarbonates
- Fundus examination for retinopathy
- Investigations for causes of 2° HT (given above)

A case of chronic cor pulmonale

1. Introduction

- **a.** Cor pulmonale is right ventricular dilatation with or without hypertrophy secondary to
  - (i) chronic lung disorders,
  - (ii) thoracic deformities or
  - (iii) pulmonary vascular disorders that produce PHT.
- **b.** Occurs in middle and old age with M:F ratio of 2:1. Poverty, pollution, overcrowding, malnutrition and smoking are contributory factors for chronic lung diseases. Hypoxia is a strong vasoconstrictor of pulmonary vasculature.

2. Causes

- **a.** Lung diseases – Chronic bronchitis, emphysema, bronchial asthma, idiopathic pulmonary fibrosis, pneumoconiosis (causes of obstructive and restrictive lung diseases)
- **b.** Kyphoscoliosis
- **c.** Obesity with hypoventilation
- **d.** Neuromuscular diseases
- **e.** Idiopathic alveolar hypoventilation
- **f.** Primary PHT.

3. Clinical features

Stage 1 – Chronic pulmonary disease
Stage 2 – Stage 1 + PHT + RVH (cor pulmonale)
Stage 3 – Stage 2 + CCF (cor pulmonale with CCF)

Note – Due to emphysema, signs of PHT and RVH are often masked. Right ventricular hypertrophy in emphysema can be confirmed by feeling downward pulsations of hypertrophied and dilated RV in the epigastrium.

4. Investigations

- **a.** Complete blood count – 2° polycythemia may be present.
- **b.** Chest X-ray PA view – Signs of emphysema, prominent hilar shadows due to dilatation of pulmonary arteries with attenuation of distal branches, right atrial and right ventricular enlargement and SVC dilatation.

   - **c.** Electrocardiogram – RVH with strain. Clockwise rotation, right axis deviation and P-pulmonale (see Fig. 10.3)
   - **d.** Pulmonary function test – Obstructive or restrictive lung defect
5. **Course**
   - **a.** Prognosis varies according to the stage of the disease
   - **b.** Recurrent lung infections worsen CCF.
6. **Management – Principles**
   - **a.** Aggressive preventive and symptomatic treatment of bronchitis and asthma to delay development of emphysema and cor pulmonale. No smoking. Avoid smoky and dusty areas.
   - **b.** Antibiotics for infection
   - **c.** Bronchodilators
   - **d.** Mucolytics and expectorants
   - **e.** Nebulization, steam inhalation
   - **f.** Chest physiotherapy
   - **g.** Diuretics and low-sodium diet for CCF. Avoid digitalis. Avoid aggressive diuretic therapy as it causes alkalosis with respiratory depression
   - **h.** Intermittent oxygen therapy, chest physiotherapy
   - **i.** *Hemophilus influenzae* and pneumococcal vaccination

A case of pericarditis

1. **Types**
   - **a.** Acute – Acute dry fibrinous or acute pericarditis with effusion.
   - **b.** Chronic – Pericardial effusion; chronic constrictive pericarditis.
2. **Causes**
   - Rheumatic fever
   - Infections – TB, viral (Coxsackie, Epstein-Barr, varicella), pyogenic, fungal, parasitic.
   - Collagen vascular diseases – SLE, scleroderma, rheumatoid arthritis.
   - Uremia
   - Idiopathic
   - Postmyocardial infarction (Dressler's syndrome)
   - Posttraumatic (surgical, nonsurgical trauma)
   - Postoperative (postpericardiotomy)
   - Postradiation
   - Sarcoidosis
   - Drug induced (hydralazine, procainamide, minoxidil)
   - Myxedema
   - Serum sickness
   - Malignancy
   - Chylopericardium
3. **Salient clinical features**
   - **a. Acute dry pericarditis**
     - **i.** Precordial chest pain (sharp) worsened by cough, breathing; worse on lying and better in sitting position with mild dyspnea, fever, malaise, body ache and arthralgia.
     - **ii.** Pericardial friction rub.
     - **iii.** Electrocardiogram – ST elevation with concavity upwards (Fig. 10.24).
     - **iv.** Cardiac enzymes/troponin – may be elevated
     - **v.** Chest X-ray – normal
     - **vi.** Viral serology, blood cultures
     - **vii.** Thyroid function tests.
   - **b. Pericarditis with effusion**
     - **i. Symptoms**
       - Dyspnea is a prominent symptom. Patient feels better in sitting and forward leaning position.
       - In massive effusion, pressure symptoms like cough, dysphagia, hoarseness of voice.
     - **ii. Signs**
       - Pulsus paradoxus (Fig. 3.6), engorged neck veins (see Fig. 1.27), Kussmaul's sign, tender hepatomegaly, ascites and edema feet.
       - Precordial bulging, weak or non palpable apex beat, increased area of cardiac dullness, left border of heart beyond apex beat, shifting dullness in left 2nd space, dull note on right side of sternum in 5th ICS (Rotch's sign), dullness, bronchial breathing and egophony in left infrascapular region (Ewart's sign).
       - Distant heart sounds, pericardial rub (±).

iii. Investigations

- Chest X-ray, cardiac silhouette increased with loss of chamber and blood vessels contours (Fig. 3.50).
- Electrocardiogram – sinus tachycardia, low voltage with inverted T waves.
- Diagnostic paracentesis, send fluid for Gram's stain, culture, Ziehl–Neelsen stain, culture for acid-fast bacilli, biochemistry and cytology.

iv. Complications – The important complications is cardiac tamponade

- A medical emergency.
- Due to rapid increase in fluid or large effusion that impairs cardiac filling.
- Tachycardia, dyspnea, paradoxical pulse, fall in BP, elevated JVP, Kussmaul's sign, increased area of cardiac dullness, distant heart sounds are the key features. It can sometimes lead to shock and death.
- Electrocardiogram – Tachycardia, low-voltage QRS complexes and inverted T waves.
- Chest X-ray – Enlarged cardiac shadow (silhouette).
- 2D echo – Pericardial fluid seen as echo-free space and heart seen moving with swinging or as free floating heart.

v. Treatment

- Treat the cause
- In cardiac tamponade, urgent removal of fluid.

A case of chronic constrictive pericarditis

1. **Etiology** – Usually sequele of tuberculous pericarditis. Other causes are hemopericardium, cardiac surgery, mediastinal irradiation, rheumatoid arthritis and SLE. Dense and rigid thickening of pericardial layers encases the heart, restricting its diastolic filling.
2. **Symptoms and signs**
   - **a.** Dyspnea, abdominal distension (ascites), swelling of feet, fatigue and weight loss.
   - **b.** Pulsus paradoxus, engorged neck veins, Kussmaul's sign, apex beat not visible, pericardial knock sound (loud S3 due to abrupt rapid filling of ventricle) (Fig. 3.19), tender hepatomegaly, ascites and edema feet.
3. **Investigations**
   - **a.** Electrocardiogram – Low-voltage, inverted T waves, AF (sometimes).
   - **b.** Chest X-ray – Heart size usually normal but can be small or large, pericardial calcification is diagnostic (Fig. 3.51).
   - **c.** 2D echo confirms pericardial thickening and calcification. Doppler echocardiography for DD from restrictive CMP.
   - **d.** Cardiac catheterization.

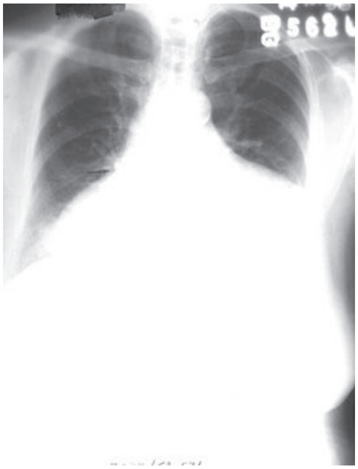

Figure 3.50 Pericardial effusion.

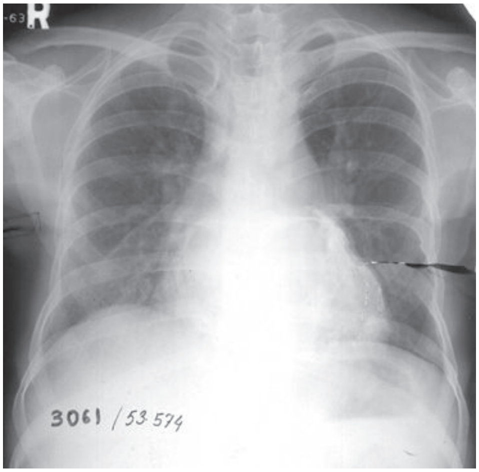

Figure 3.51 Pericardial calcification.

4. **Treatment**
   a. Pericardial resection
   b. Anti-TB treatment before and after surgery if a definite etiological diagnosis is not made

A case of cardiomyopathy

Classification – Pathological (WHO classification)

1. Dilated CMP
2. Restrictive CMP
3. Hypertrophic CMP

Dilated CMP (Fig. 3.52)

1. **Introduction** – Cardiac chambers dilated, both sides commonly affected, pumping action impaired due to systolic dysfunction resulting in CCF.
2. **Causes** – Most common causes are infections (particularly viral), toxic (e.g. alcohol), metabolic (DM), and ischemic.
3. **Symptoms** – Dyspnea of various grades, depending upon severity of myocardial damage.
4. **Signs** – Low volume pulse, low SBP, raised JVP, cardiomegaly, MR and TR, tender hepatomegaly with ascites, edema legs. Signs of LVF – pulsus alternans, S3, S4, loud P2 (PHT).
5. **Investigations**
   a. Chest X-ray – Cardiomegaly (Fig. 3.53), pulmonary venous congestion, pleural effusion especially on right side
   b. Electrocardiogram – Low voltage with flat or inverted T waves, tachycardia
   c. 2D Echo – generalized heart enlargement. Also rules out other causes of cardiomegaly
6. **Prognosis** – Five-year survival (30%).
7. **Management** (basically of CCF).

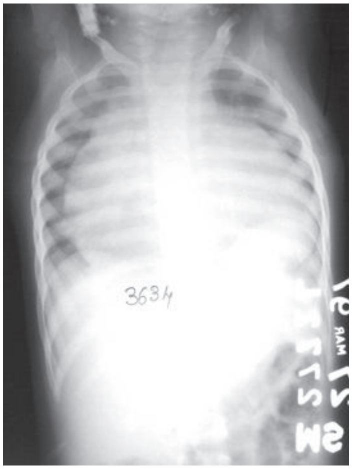

Figure 3.53 Dilated CMP.

Restrictive CMP (RCM) (Fig. 3.52)

Its clinical presentation is like that of chronic constrictive pericarditis. These two conditions should be differentiated because chronic constrictive pericarditis is curable with surgical resection, whereas for RCM, we can offer very little (Table 3.6).

There is decreased compliance of myocardium due to abnormal ventricular diastolic function with almost normal systolic function.

Chest pain with dyspnea due to pulmonary venous congestion is the presenting symptom.

Normal/forcible AB, signs of MR and loud P2 favor restrictive cardiomyopathy.
Chest X-ray – Pulmonary venous HT and pulmonary edema common.
Electrocardiogram – LVH, LBBB, complete heart block.
2D echo helps to differentiate chronic constrictive pericarditis and restrictive cardiomyopathy.

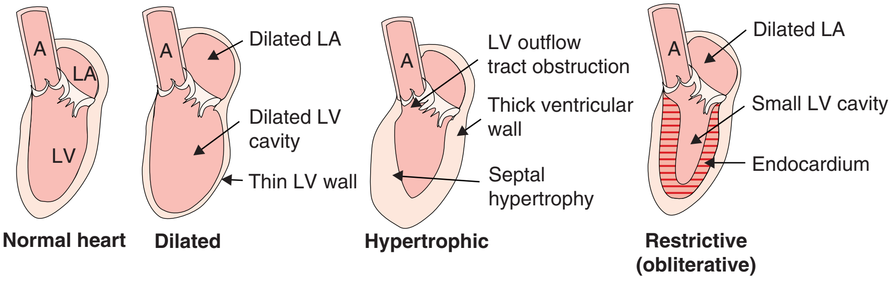
A
LA
LV
Normal heart
A
Dilated LA
Dilated LV cavity
Thin LV wall
Dilated
A
LV outflow tract obstruction
Thick ventricular wall
Septal hypertrophy
Hypertrophic
A
Dilated LA
Small LV cavity
Endocardium
Restrictive (obliterative)

Figure 3.52 Different types of CMP.

Table 3.6 Differential features of restrictive CMP and chronic constrictive pericarditis

Features	Restrictive CMP	Chronic constrictive pericarditis
Complaints	Dyspnea, distension of abdomen, swelling legs	Same
Jugular venous pressure	Raised	Raised, Kussmaul's sign +, prominent X and Y descent (Fig. 3.11)
S3	±	Pericardial knock
S4	±	–
2D echo		
Pericardium	Normal	Thickened, calcification (majority cases) (Fig. 3.51)
Myocardium	Thickened (mostly)	Normal

Endomyocardial biopsy may help in confirming infiltrative disorders causing RCM.

Hypertrophic obstructive CMP (Fig. 3.52)

1. **Etiology**
    - **a.** Familial, autosomal dominant disorder.
2. **Pathology**
    - **a.** Hypertrophy of left ventricular wall with small or normal LV cavity.
    - **b.** Hypertrophy of subaortic area causing obstruction to the outflow tract of LV.
    - **c.** Hypertrophy symmetrical (concentric) or asymmetrical (midventricular, apical, septal, posteroseptal and/or lateral wall).
    - **d.** Predominantly diastolic dysfunction (due to both chamber stiffness and impaired relaxation).
3. **Symptoms**
    - **a.** Atypical angina even at rest, not relieved by nitrates.
    - **b.** Dyspnea, syncope, palpitations (supraventricular and ventricular arrhythmias), sudden death.

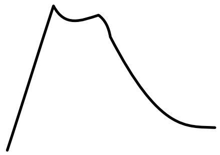

Figure 3.54 Jerky pulse (HOCM).

(HOCM is a common cause of sudden death in young athletes).

4. **Signs**
    - **a.** Jerky pulse (Fig. 3.54), bisferiens pulse (appreciated in carotids) (Fig. 3.6), AB shifted down and out (heaving).
    - **b.** Heart sounds – S1 normal, S2 normal or paradoxically split, S4 common, S3 uncommon.
    - **c.** Late systolic (ejection type) murmur best audible along left lower sternal border in 3rd or 4th ICS or midprecordial region which increases with valsalva maneuver and diminishes with handgrip. It is not transmitted to carotids. Mitral regurgitation murmur may be present at apex.
5. **Investigations**
    - **a.** Electrocardiogram – LVH + nonspecific ST-T changes. Deep Q waves (due to septal hypertrophy in lead I, aVL, V5 and V6), LAE and short P-R interval.
    - **b.** Chest X-ray – Usually normal.
    - **c.** 2D echo – Diagnostic; confirms LVH, septal hypertrophy and LAE.
6. **Management**
    - **a. Medical**
        - **i.** Beta-blockers are the first drugs of choice. Alternatively, calcium channel blockers (verapamil) can also be used.
        - **ii.** Amiodarone for supraventricular and ventricular arrhythmias.
    - **b. Surgical**
        - **i.** Septal myotomy/myectomy to broaden the LV outflow tract, catheter alcohol ablation.
        - **ii.** Mitral valve replacement for severe MR.
        - **iii.** Avoid competitive sports.
        - **iv.** Infective endocarditis prophylaxis.

A case of atrial septal defect

Types

- Ostium secundum at the level of fossa ovalis (commonest type)
- Ostium primum, endocardial cushion defect (uncommon)
- Sinus venosus

Atrial septal defect is mostly isolated but can be part of various syndromes.

Ostium secundum

1. **Symptoms** – Majority are asymptomatic, and this defect is compatible with normal life. Mild chest discomfort or mild dyspnea may be present. Chest infections are common. Paradoxical embolism can occur.
2. **Signs** – S2 is widely split and fixed with loud P2 component (Fig. 3.20). Ejection systolic or midsystolic murmur (Grades 2 and 3) is heard over pulmonary area and a mid-diastolic flow murmur over tricuspid area with large L-R shunt. With reversal of shunt, central cyanosis develops (Eisenmenger's syndrome).
3. **Investigations**
    a. Electrocardiogram – Incomplete RBBB with prolonged P-R interval, right axis deviation, AF is common in ASD.
    b. Chest X-ray – Mild cardiomegaly, pulmonary plethora. There is dilatation of right atrium, RV and prominent PA with less prominent aortic knuckle giving 'Jug Handle' appearance (Fig. 3.55).

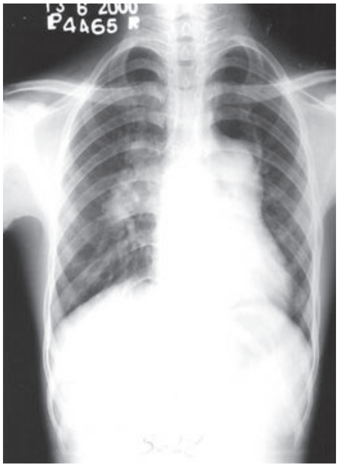

Figure 3.55 Atrial septal defect.

    c. 2D echo – Contrast echocardiography diagnostic, as it delineates the shunt.
    d. Transesophageal echocardiography is useful.
4. **Differential diagnosis of ASD**
    a. Partial anomalous venous connection can resemble acyanotic ASD.
5. **Management**
    a. Treatment – Closure of ASD (percutaneous catheter technique or surgery) is done when the Qp:Qs ratio (pulmonary to systemic flow ratio) is more than 1.5:1 or when there are repeated chest infections.

Ostium primum (endocardial cushion defect)

- The defect may be only interatrial (ostium primum ASD) or may be only interventricular. Separate mitral and tricuspid valves are present in intermediate forms. A common atrioventricular valve presents complete form.
- In 30%, associated with Down's syndrome.
- Pansystolic murmur in mitral, tricuspid areas due to MR and TR.
- Electrocardiogram – Left axis deviation, prolonged P-R interval, incomplete RBBB, LVH (when MR present).
- Chest X-ray – Cardiomegaly, prominent PA with pulmonary plethora.
- 2D echo delineates all defects.
- Treatment is surgical correction.

Sinus venosus type

- Defect is high in the septum near SVC junction.
- This may be associated with partial anomalous pulmonary venous connection.
- Electrocardiogram – Inferior leads may show inverted P waves. Rhythm may be junctional.
- Chest X-ray shows dilatation of SVC.

A case of isolated ventricular septal defect

Ventricular septal defect is the commonest congenital heart disease (30%).

1. **Types**
    Broadly of two types
    a. Perimembranous (most common 75–80%)
    b. Muscular VSD (5–20%)

2. **Symptoms and signs**
   a. Clinical features depend upon the size of the defect. Small defects are asymptomatic and children grow normally.
   b. Large defects become symptomatic very early in life (infants). Present with heart failure and/or recurrent chest infections.
   c. Untreated VSD patients develop Eisenmenger's complex (reversal of shunt from right to left side across the VSD).
   d. Good volume pulse (small water hammer pulse), forcible apex beat, cardiomegaly, parasternal systolic thrill, pansystolic murmur over midprecordial region (lower left sternal border). S3 in mitral area (small shunts) and mid-diastolic flow murmur at the apex (large shunts).
3. **Investigations**
   a. Electrocardiogram – Normal (small VSD), biventricular hypertrophy (large VSD).
   b. Chest X-ray – Normal (small VSD); cardiomegaly plus pulmonary plethora and prominent PA (large VSD) (Fig. 3.56).
   c. 2D echo and color Doppler for size and site of defect and degree of shunt.
   d. Cardiac catheterization – Essential before surgery to assess site, number of defects and degree of shunt.
4. **Complications**
   a. Left ventricular failure
   b. Pulmonary hypertension
   c. Infective endocarditis
   d. Pulmonary hypertension with reversal of shunt (Eisenmenger's complex) (Fig. 3.57)
5. **Prognosis**
   a. With small muscular defect, spontaneous closure may occur in 50% by 2 years of age.
   b. Those having large VSD should be operated before 2 years of age. If left alone, increased pulmonary vascular resistance may lead to development of Eisenmenger's complex by 11–15 years of age.
6. **Management**
   a. Medical – Treatment of chest infections, heart failure and IE.
   b. Surgical – Early closure before the pulmonary vascular resistance develops.

A case of patent ductus arteriosus

1. **Etiology**
   - Premature infants, infants born at high altitudes and infants born to mothers having or had rubella in 1st trimester.
   - Common 10% of congenital heart diseases.
2. **Clinical features**
   - Presenting symptoms – Heart failure and chest infections.
   - Water hammer pulse, pulsatile carotids, bounding peripheral pulses, apex beat

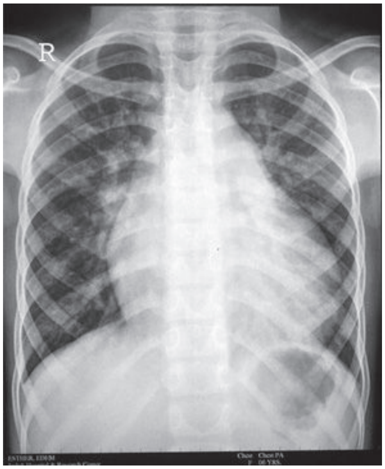

Figure 3.56 Chest X-ray – Large VSD – cardiomegaly with pulmonary hypertension.

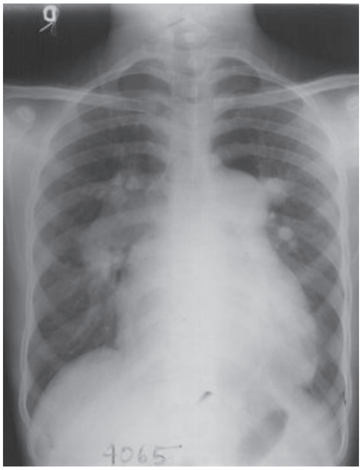

Figure 3.57 Eisenmenger's complex.

hyperdynamic and forcible, hyperactive precordium, pulsations in suprasternal notch, continuous thrill, and continuous machinery murmur over left 2nd space (Fig. 3.20), S3 (small shunts), mid-diastolic flow murmur (large shunts) over apex.

3. **Differential diagnosis**
   - arteriovenous (coronary, systemic, pulmonary) fistula over precordium
   - Ventricular septal defect +AI which have to-and-fro murmur, and it should not be mistaken with continuous murmur of PDA.
4. **Causes of continuous murmur**
   - Patent ductus arteriosus
   - Aortopulmonary window
   - Rupture of sinus of Valsalva aneurysm
   - Coronary arteriovenous fistula
   - Pulmonary AV fistula
   - Venous hum
5. **Investigations**
   - a. Electrocardiogram – LVH
   - b. Chest X-ray – Cardiomegaly (LV+ and LA+), prominent PA with pulmonary plethora
   - c. 2D echo with color doppler detects PDA
   - d. Cardiac catheterization – Catheter passes from PA to duct to descending aorta. Aortic root angio confirms PDA
6. **Complications** – Pulmonary vascular resistance develops depending upon severity of leak. As PA pressure (PAP) rises, diastolic murmur disappears. When PAP is more than aortic pressure, shunt reverses, murmur disappears and there is differential cyanosis (cyanosis of toes with pink fingers).
7. **Management**
   - a. **Medical**
     - i. One may try indomethacin within first week of birth in premature infants which may close the ductus.
     - ii. Treatment of heart failure and chest infections.
   - b. **Surgical**
     - i. Closure (percutaneous Rashkind umbrella or coils). Open heart surgery is to be done at the earliest preferably below 2 years of age.

A case tetralogy of Fallot (TOF)

1. **Anatomy**
   - a. Four defects
     - i. Ventricular septal defect
     - ii. Right ventricle outflow tract obstruction (infundibular)
     - iii. Overriding aorta
     - iv. Right ventricle hypertrophy

   Other anomaly frequently associated is right-sided aortic arch.
2. **Prevalence** – 7–10% of all congenital heart diseases.
3. **Symptoms** – There is right to left shunt with central cyanosis which increases with exertion and crying. Hypoxic spells (cyanosis, tachypnea, syncope and occasionally convulsions), which can be fatal. Squatting after exertion is characteristic (Fig. 3.58).
4. **Signs** – Clubbing, central cyanosis (Fig. 3.58), low volume pulse, quiet precordial impulse, no cardiomegaly. Ejection midsystolic murmur over left 3rd space (infundibular stenosis) followed by single loud S2 (aortic component) is a characteristic auscultatory finding (Fig. 3.20).
5. **Investigations**
   - a. Electrocardiogram – RVH and RAD
   - b. Chest X-ray – Typical boot-shaped heart (coeur en sabot) (RVH + concave

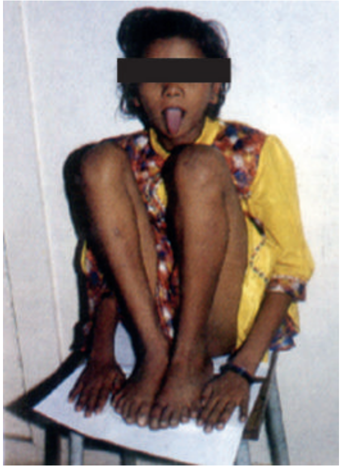
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Figure 3.58 Fallot's tetralogy showing squatting, cyanosis and clubbing.

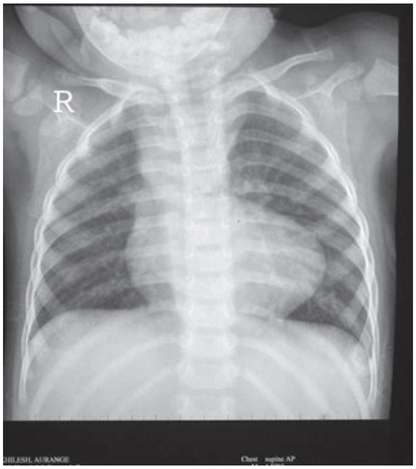

Figure 3.59 Fallot's tetralogy – Boot-shaped heart, right-sided aortic arch.

PA segment), oligemic lung fields (Fig. 3.59).

   c. 2D echo – Identifies the four defects.
   d. Cardiac catheterization – Delineates the defects clearly (for the surgeon).

6. **Complications**
   a. Brain abscess
   b. Secondary polycythemia resulting in intravascular thrombosis leading to paradoxical emboli and cerebrovascular accidents.
   c. Infective endocarditis
7. **Prognosis**
   a. Poor without surgery.
8. **Management**
   a. **Medical** – Anoxic spells relieved by patient assuming knee chest position or squatting plus oxygen inhalation, mild sedation and fluids for volume expansion. For prevention of spells, propranolol (which relieves infundibular spasm) is recommended. Infective endocarditis prophylaxis.
   b. **Surgical** – Palliative – Symptomatic children less than 2 years, aortopulmonary shunt (Blalock–Taussig shunt), subclavian to PA shunt or ascending aorta to pulmonary artery (Waterston–Cooley) shunt.
   c. **Curative** – Total correction done in children above 1 1/2 years.

Acyanotic Fallot – When resistance to pulmonary outflow is lower than the systemic resistance, shunt is from left to right across VSD; hence, no cyanosis.

Viva voce

Q1. What are the syndromes associated with ASD?

- **Lutembacher's syndrome (ASD + acquired MS)** – ASD may be associated with MVP.
- **Holt–Oram syndrome** – Autosomal dominant ASD (secundum type) plus triphalangeal (fingerized) thumb, sometimes phocomelia.
- **Edward syndrome (trisomy 18)** – ASD plus prominent occiput, micrognathia, low-set malformed ears, rocker bottom feet.
- **Patau syndrome (trisomy 13)** – ASD plus polydactyly, cleft lip and palate and low-set malformed ears. Note – Trisomy 18 and trisomy 13 can be associated with VSD or PDA instead of ASD.

Q2. What are the common syndromes associated with VSD?

- **Trisomy** – 13, 18 and 21
- **Cri du chat syndrome** – Cat cry, mental retardation, microcephaly
- **Klippel–Feil syndrome** – Fusion of the cervical vertebrae, low hairline (short neck)
- **Cornelia de Lange syndrome** – Mental and growth retardation, micromelia
- **Alport syndrome** – Craniosynostosis, syndactyly

Q3. What is Maladie-de-Roger syndrome?

Here there is small size muscular VSD with systolic thrill and loud pansystolic murmur but no hemodynamic changes. Even ECG is normal and prognosis is good. The defect may close spontaneously.

Q4. When is surgery indicated in ASD secundum type and VSD?

When pulmonary to systemic blood flow is greater than 1.5:1.

Q5. What syndromes are associated with PDA?

- Trisomy 18
- Maternal rubella syndrome – Deafness plus cataract plus microcephaly
- Crouzon syndrome – Craniosynostosis, maxillary hypoplasia, ptosis with shallow orbit
- Fetal hydantoin syndrome – Growth and mental retardation, hypertelorism, short phalanges

Q6. In what situations patent PDA is life saving?

- Preductal coarctation of aorta
- Hypoplastic left heart
- Pulmonary atresia

Q7. What are Eisenmenger's syndrome and Eisenmenger's complex?

Pulmonary hypertension with reversal of shunt at ASD and PDA levels is Eisenmenger's syndrome and at VSD level is termed Eisenmenger's complex. Salient features are

- Central cyanosis – In PDA, differential cyanosis (cyanosis in feet and not in hands)
- Clubbing
- Polycythemia
- Right ventricular hypertrophy – RV heave in left parasternal region and epigastric region
- P2 palpable – Diastolic shock
- Ejection click and ejection systolic murmur over pulmonary area with loud P2
- Pansystolic murmur over tricuspid area increasing on inspiration (functional TR)
- Original murmurs of VSD, ASD and PDA diminish in intensity and decrease in duration

Q8. How will you differentiate between dextrocardia and dextroversion at bedside?

Feel for trachea which is central in dextrocardia, whereas it is shifted to right side in dextroversion because dextroversion is due to either pleural effusion or pneumothorax on left side, which pushes trachea and heart to right side, or due to fibrosis or collapse of right lung, which pulls trachea and heart to right side.

A case of aortic aneurysm

Definition

When there is 50% increase in arterial diameter compared to normal segment, it is labeled aneurysm.

Types

1. Fusiform – Diffuse enlargement of a segment of aorta usually ascending aorta (circumferential widening of artery) (Fig. 3.60).
2. Saccular – Localized outpouching of the arterial wall, usually arch of aorta or descending aorta (Fig. 3.60).

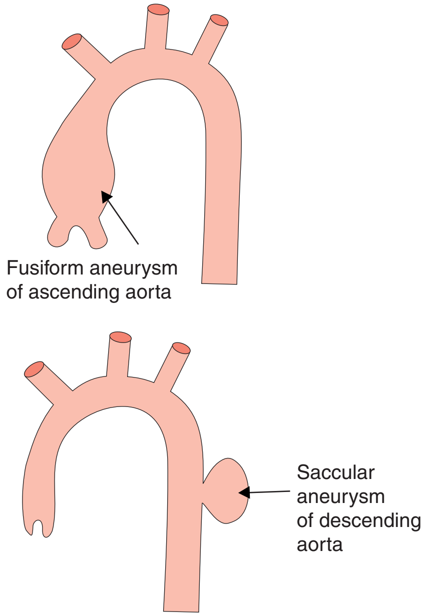
Fusiform aneurysm of ascending aorta
Saccular aneurysm of descending aorta

Figure 3.60 Types of aortic aneurysms.

3. Pseudoaneurysm results from arterial rupture resulting in communication between arterial lumen and surrounding connective tissue.
   1. **Etiology**
      - **a.** Atherosclerosis (common) involves any part – Arch, descending aorta and abdominal aorta.
      - **b.** Syphilitic (rare nowadays) – Usually ascending aorta.
   2. **Clinical features** – Thoracic aneurysms present usually with pressure symptoms.
      - **a.** Aneurysm of AA causes pressure on SVC, tracheobronchial tree, lung, causing engorgement of neck veins, wheezing, cough, dyspnea and hemoptysis.
      - **b.** Aneurysm of arch compresses trachea, esophagus, SVC, recurrent laryngeal nerve leading to stridor and hoarseness of voice, dyspnea, engorged neck veins and Horner's syndrome. Tracheal tug is present (Fig. 3.61).
      - **c.** Aneurysm of descending aorta causes variable compression symptoms according to the site of aneurysm.
      - **d.** Pressure over adjacent musculoskeletal structures causes pain.
      - **e.** Abdominal – Majority are asymptomatic. In symptomatic patients,

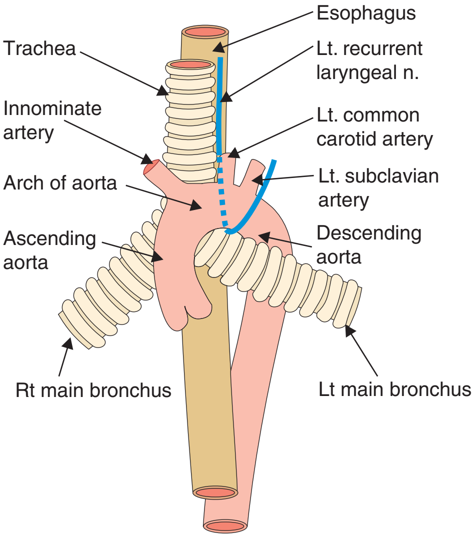

Figure 3.61 Anatomical interrelationships of esophagus, trachea and aorta.

there is steady, deep, boring pain, most prominently in lumbosacral region. Pulsatile mass over abdomen may be felt and systolic bruit may be heard.

3. **Complications** – Rupture of aneurysm, endoarteritis, peripheral embolism, pain in limbs.
4. **Investigations**
   a. Chest X-ray shows the aneurysmal bulge (Fig. 3.62).

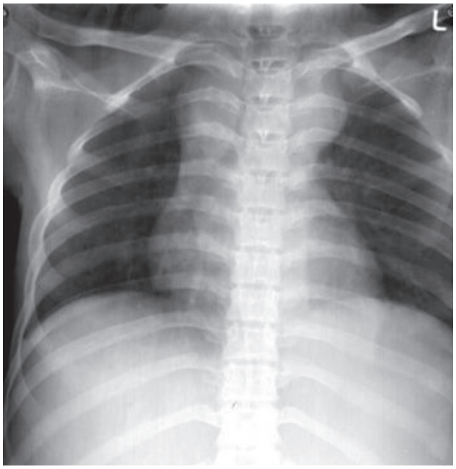

Figure 3.62 Aortic arch aneurysm.

   b. Aortography is diagnostic. Alternatives are CT angiography, ultrasonography and MRI.
5. **Treatment** – Surgical resection plus graft replacement. Aneurysms more than 6 cm in width (high incidence of rupture).

Viva voce

Q1. Describe briefly dissecting aneurysm of aorta?

Dissection starts with intima tear followed by surging of blood column forced by BP into dissection through the tear with separation of intima and media. This creates a false lumen. Patient gets ripping chest pain starting at site of tear and traversing along the dissection. Usually mistaken with AMI, but ECG and cardiac enzymes are normal. DeBakey has classified dissecting aneurysm as follows: **Type 1**, begins in AA and extends up to the aortic arch or beyond; **Type II**, dissection restricted to AA; and **Type III**, commences in descending aorta beyond left subclavian artery origin, propagates down up to the diaphragm (**III a**) or extends below the diaphragm (**III b**) (Fig. 3.63).

A case of aortoarteritis (Takayasu's arteritis)

1. **Introduction**
   a. Takayasu (a Japanese ophthalmologist) described it in 1908.
   b. Nonspecific inflammatory condition segmentally affecting the aorta and its branches.
   c. Exact etiology not known.
2. **Clinical features** – Predominantly affects young females.
   a. **Acute phase**
      i. Presents with fever, malaise, loss of appetite and weight, arthralgia.
   b. **Chronic phase**
      i. Involvement of upper extremity vessels presents a clinical picture of reversed coarctation with weak upper limb pulses and good volume lower limb pulses.
      ii. With abdominal aorta involvement presents with pain in abdomen, claudication and renal HT.

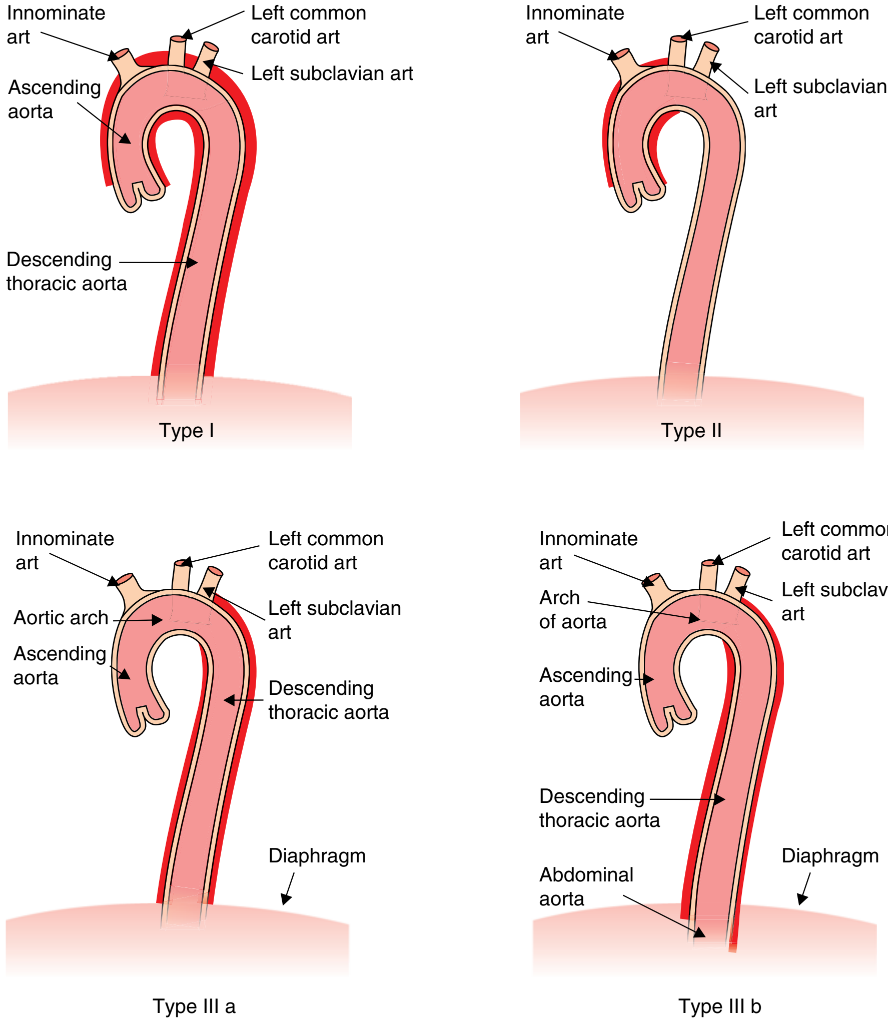
Innominate art
Left common carotid art
Left subclavian art
Ascending aorta
Descending thoracic aorta
Type I
Innominate art
Left common carotid art
Left subclavian art
Type II
Innominate art
Left common carotid art
Aortic arch
Left subclavian art
Ascending aorta
Descending thoracic aorta
Diaphragm
Type III a
Innominate art
Left common carotid art
Left subclavian art
Arch of aorta
Ascending aorta
Descending thoracic aorta
Abdominal aorta
Diaphragm
Type III b

Figure 3.63 Types of dissecting aneurysms of aorta (DeBakey's classification).

- **iii.** Ascending aorta involvement may result in AR, coronary artery involvement with MI and heart failure.
- **iv.** Cranial vessel involvement leads to stroke, headache, hypertensive encephalopathy and retinopathy.
- **v.** Pulmonary artery involvement with PHT.

3. Investigations

- **a. Acute phase** – Leukocytosis, raised ESR, low Hb, raised IgG and IgM, CRP and fibrinogen levels.
- **b. Chronic phase** – Aortography, MR angiography, CT angiography and color Doppler are useful diagnostic modalities (Figs. 3.64 and 3.65).

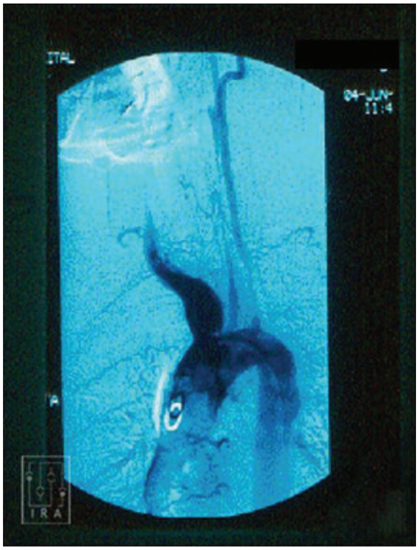

Figure 3.64 Aortography showing arteritis of arch of aorta.

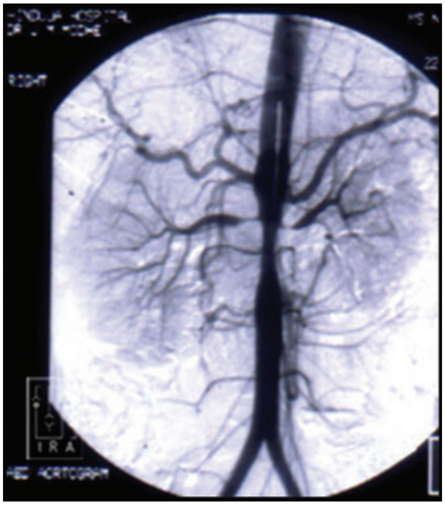

Figure 3.65 Aortography showing arteritis of abdominal aorta.

4. **Treatment**
   a. **Medical**
      i. Steroids plus immunosuppressive drugs (e.g. methotrexate) to control disease activity even in chronic phase.
      ii. Precaution with bilateral renal artery stenosis, avoid ACE inhibitors.
      iii. Anticoagulation is helpful and aspirin is useful.
   b. **Surgical treatment**
      i. Bypass surgery especially with renal artery involvement; excision of saccular aneurysm.
      ii. Angioplasty with stenting in suitable cases.

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Chapter 4

Respiratory system

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INTRODUCTION

Evaluation of a patient with respiratory disease involves proper history taking, physical examination and investigations such as chest X-ray, complete blood count (CBC), erythrocyte sedimentation rate (ESR), lung function tests, sputum examination and Mantoux test. Special investigations such as CT, MRI chest. Bronchoalveolar lavage, bronchoscopy, diagnostic pleural aspiration, pleural and lung biopsies are carried out whenever necessary.

COMMON RESPIRATORY SYMPTOMS

1. **Cough** – It may be dry or accompanied with sputum. Note the duration, timing and trigger factors. Also note whether cough is seasonal (during monsoon or winter) or aggravated by dust, smoke, pollen, cold air, cold drinks and spicy foods.

   Types of cough

   i. **Dry cough** indicates little or no exudate in mucous membranes of larynx, trachea and bronchi. Dry cough usually present in the early stages of infection or indicates bronchial irritation due to smoke and irritant gases. Dry cough may be a manifestation of growth in the bronchus or extrinsic pressure on tracheobronchial tree.

ii. **Productive cough** (with expectoration) indicates presence of exudate (sputum)
iii. **Nocturnal cough** – Dry cough at night may be an early symptom of LVF and bronchial asthma especially if patient gets spasms of cough accompanied by breathlessness (Box 4.1)
iv. **Paroxysmal cough** may be due to chronic bronchitis, whooping cough, foreign body (especially in children) and aspiration. A severe and prolonged paroxysm of cough may be associated with vomiting and syncope
v. **Early morning cough** with expectoration is characteristic of chronic bronchitis and pulmonary tuberculosis
vi. **Seasonal cough** is usually seen with chronic bronchitis
vii. **Brassy cough** is due to pressure over trachea
viii. **Barking cough** is due to epiglottal involvement and hysteria.

Causes of nocturnal cough **Box 4.1**

- Left ventricular failure (LVF)
- Bronchial asthma
- Angiotensin-converting enzyme inhibitors
- Chronic bronchitis
- Aspiration (postnasal drip, esophageal obstruction, gastroesophageal reflux)

2. **Sputum** – Enquire and note the quantity, consistency (Box 4.2) and color of sputum. The sputum quantity of more than a cupful in 24 hours suggests bronchiectasis, lung abscess or empyema rupturing into a bronchus (additionally, sputum may have an offensive smell). Yellowish or greenish color suggests bacterial infection. Confirm whether sputum is blood stained or there is hemoptysis. The commonest cause of blood in sputum is pulmonary tuberculosis. In bronchial asthma, yellowish sputum is usually due to eosinophils but can be due to secondary bacterial infection. Chronic smokers have chronic bronchitis usually with white mucoid sputum. Rusty sputum is characteristic of pneumonia. In pulmonary edema, sputum is frothy and pink or may contain frank blood. Red currant jelly sputum is seen in Klebsiella pneumonia. Anchovy sauce sputum is seen when an amebic liver abscess ruptures into the lung.

Consistency of sputum may be **Box 4.2**

- Serous – Thin watery
- Mucoid – Clear, grayish white and frothy
- Mucopurulent – Yellowish or greenish mixed with mucoid sputum.

3. **Dyspnea** – Breathlessness or dyspnea is undue awareness of respiratory effort or a need to increase respiratory effort. It may be present at rest or during exertion (Box 4.3), preceded by cough. Nocturnal and early morning dyspnea is often seen with asthma. It should be differentiated from paroxysmal nocturnal dyspnea of cardiac origin (cardiac asthma) in which breathlessness develops at midnight accompanied with chest discomfort, suffocation and air hunger. Pollens, dust and smoke can act as triggers of asthma. Asthmatics and chronic bronchitis patients experience worsening of breathlessness on exertion.

   Anxious patients have sighing breathing (air hunger), which is interpreted as breathlessness. Also, they may over ventilate with washing out of CO_2, resulting in dizziness, paresthesias and tetany (due to alkalosis).

Medical research council grading of exertional dyspnea **Box 4.3**

- Grade I – Dyspnea when hurrying on ground level or walking up a small hill
- Grade II – Dyspnea when walking with people of same age on ground level
- Grade III – Dyspnea (sufficient to necessitate stopping) when walking at one's own pace on ground level

4. **Wheezing** – History of wheezing may be provided by family members or the patient. It is a feature of bronchial and cardiac asthma.

Causes of wheezing –

- Asthma (most classic cause)
- Chronic obstructive pulmonary disease (COPD)
- Tropical eosinophilia
- Cardiac asthma
- Bronchiolitis (in children)
- Anaphylaxis
- Toxic gas inhalation
- Aspiration
- Carcinoid syndrome

5. **Stridor** – It is loud and harsh predominantly inspiratory breathing due to upper airways obstruction. As against asthma, where there is expiratory difficulty, stridor is mainly inspiratory.

Causes of stridor –

- Foreign body aspiration (common in children)
- Diphtheria
- Whooping cough
- Croup, acute laryngotracheobronchitis
- Acute epiglottitis
- Laryngeal edema
- Vocal cord paralysis
- Compression of trachea
- Tracheal stenosis
- Tracheomalacia and tetany

6. **Chest pain** – Lung parenchyma is insensitive to pain. Pain may be of pleural or chest wall origin. Patient may complain of myalgic chest and upper abdominal pain if suffering from bouts of cough. (See Box 4.4 for pain of acute dry pleurisy.) In **Pancoast's syndrome** (apical carcinoma of lung with Horner's syndrome), 8th cervical or 1st thoracic nerve roots may be involved when the pain is referred to the upper limb.

Characters of pleuritic chest pain **Box 4.4**

- Sharp, stabbing, tearing or cutting
- Location (axilla or beneath breast)
- Aggravated by inspiration and cough
- Relieved by lying on affected side
- May be referred to shoulder or upper abdomen

Important causes of pleuritic chest pain

i. Acute dry pleurisy
ii. Lobar pneumonia
iii. Pleurisy with effusion (before accumulation of pleural fluid or during resolving stage)
iv. Bronchogenic carcinoma (due to invasion of chest wall)
v. Pulmonary infarction
vi. Bornholm disease

7. **Symptoms pertaining to upper respiratory tract** –
   - Cold
   - Sneezing
   - Running nose
   - Sore throat
   - Sinusitis
   - Ear infection
   - Ear discharge
   - Change in voice, commonly due to laryngitis; in elderly, it could be due to carcinoma of the vocal cords

8. **Hemoptysis**

   Hemoptysis is coughing of blood from the respiratory tract. It is usually fresh blood, red in color and mixed with sputum, though patient may cough out only frank blood (Box 4.5). Hemoptysis needs to be distinguished from hematemesis (Box 4.6). One should also enquire whether blood has come from nose (epistaxis) or gums (see Chapter 1).

Severity of hemoptysis is graded as

- Mild – less than 100 ml/day
- Moderate – 100–150 ml/day
- Severe – greater than 200 ml/day
- Profuse – greater than 500 ml/day
- Massive – greater than 150 ml/hour

Causes of hemoptysis **Box 4.5**

Respiratory

- Pulmonary tuberculosis
- Bronchiectasis
- Chronic bronchitis
- Pulmonary infarction
- Endobronchial growth
- Arteriovenous malformation
- Pulmonary alveolar hemorrhage

Nonrespiratory

- Mitral stenosis
- Left ventricular failure
- Bleeding disorders (including anticoagulation)

Differences between hemoptysis and hematemesis

Box 4.6

Hemoptysis	Hematemesis
Preceded by cough	Preceded by or along with vomiting
Frothy blood	Airless blood
Mixed with sputum	Mixed with food
Bright red in color	Altered color (dark red or brown)
History of respiratory or cardiovascular disease may be present	History of upper gastrointestinal disease may be present
Alkaline pH	Acidic pH
Melena not a feature	Melena follows
Confirmed by bronchoscopy	Confirmed by upper GI endoscopy

Note – Hemoptysis is not associated with shock. On the other hand, massive hematemesis is an important cause of hemorrhagic shock.

Past history

Past history of following illnesses should be noted.
- Influenza, measles, whooping cough (childhood illnesses)
- Tuberculosis, recurrent chest infections
- Contact with known HIV patient (unprotected sex), history of blood transfusion, surgery.

Family history

Asthma or associated allergic conditions such as eczema, allergic rhinitis or hay fever run in families. Hence, family history is important for establishing diagnosis of bronchial asthma. For pulmonary tuberculosis, history of contact with a tuberculous patient in family members or friends is important.

Personal history

Details about present or past history of smoking, its duration, the number and type (cigarette, bidi, etc) and cigarette brands should be noted. Lung cancer and chronic obstructive lung disease occur more commonly in smokers.

Occupational history

One should inquire details of occupation, exposure to smoke, dusts (cotton, coal wood, asbestos, manganese), paints, sprays (rubber, plastic), etc.

Many occupational lung diseases (e.g. silicosis, byssinosis, asbestosis, worker's pneumoconiosis, berylliosis) and occupational asthma due to inhalation of organic dusts can be diagnosed if detailed occupational history is elicited.

General examination (Box 4.7)

Salient points to be noted in general examination

Box 4.7

- Conscious state, flapping tremors
- Built, development, moon face, wasting
- Decubitus
- Pulse and respiration rates; blood pressure
- Breathlessness, air hunger, movements of accessory muscles of respiration (sternomastoid, abdominals), wheezing, stridor should be noted
- Cyanosis
- Clubbing, hypertrophic osteoarthropathy, pallor, nicotine staining
- Lymphadenopathy
- Neck veins, engorged veins over chest wall
- Gynecomastia
- Hoarseness of voice, Horner's syndrome
- Prominent eyeballs

Examination of upper respiratory tract

Examine oral cavity (for caries teeth, missing teeth, tooth and gum infection), tonsils (size, inflammation, exudate), posterior wall of nasopharynx (postnasal drip), nose (nasal block, deviated nasal septum, crusting, polyps) and sinuses (maxillary, ethmoid, frontal) for tenderness (Fig. 4.1).

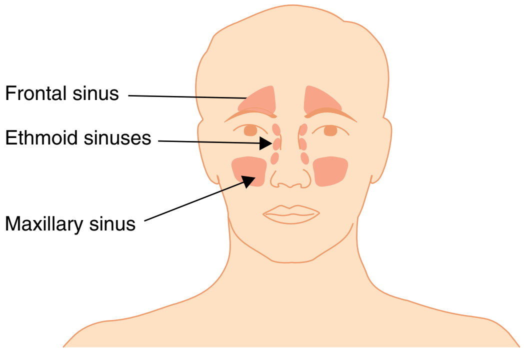


Figure 4.1 Paranasal sinuses.

Regions of the chest

For descriptive purposes, chest is divided into following regions. Anteriorly supraclavicular, clavicular, infraclavicular (lower border defined by a line drawn horizontally from angle of Louis to anterior axillary plane), mammary region (from 2nd to 6th costal cartilage) and inframammary region (below 6th costal cartilage) (Fig. 4.2).

Laterally it is divided into axillary and infra-axillary regions, dividing line being 6th rib in midaxillary plane (Fig. 4.3). Posteriorly, the regions are suprascapular (above spine of the scapula), scapular (over the scapula), infrascapular (below inferior angle of scapula) and interscapular between medial border of scapula and the vertebral column. This is further subdivided into upper and lower interscapular regions (Fig. 4.4).

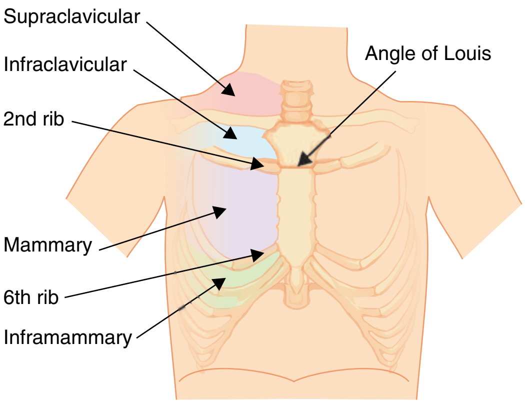


Figure 4.2 Regions of chest (anterior aspect).

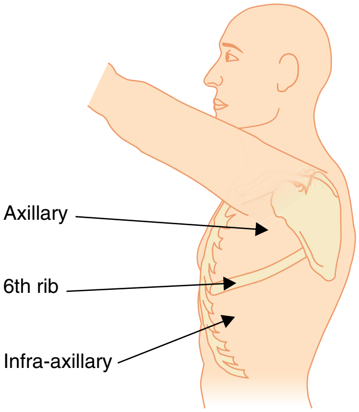


Figure 4.3 Regions of chest (lateral aspect).

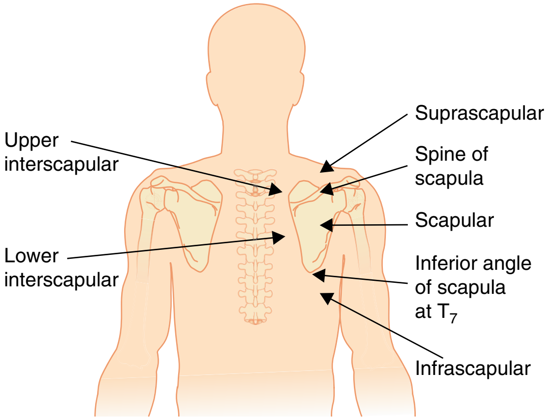


Figure 4.4 Regions of chest (back).

The front portion of chest corresponds to upper and middle lobes. Posteriorly, lower lobe corresponds to area below scapular spine (lower interscapular area and infrascapular) whereas upper lobe corresponds to area above scapular spine (upper interscapular and suprascapular areas). In axilla parts of all the three lobes are located. The apices of lungs rise about 2–3 cm above the midportion of clavicle on both the sides. The mammary region corresponds to middle lobe on the right side and lingular segment on the left side.

Surface making of trachea and lungs

Trachea bifurcates into right and left main bronchi at the level of angle of Louis (manubriosternal junction) anteriorly and intervertebral disc between 4th and 5th thoracic spine posteriorly or at the level of 4th spinous process (Fig. 4.5). (These positions are not absolutely fixed due to respiratory excursions.)

Right lung is divided into upper, middle and lower lobes, whereas left lung is divided into upper and lower lobes. The major interlobar or oblique fissure corresponds to a line drawn from second thoracic spine posteriorly to the 6th costal cartilage anteriorly. It forms the upper border of lower lobe. Additional minor or horizontal fissure on the right side corresponds to a horizontal line drawn from the sternum at the level of 4th costal cartilage that meets the major interlobar fissure in axilla in midaxillary line. This is the dividing line between the upper and middle lobes. Major part of the upper lobe is situated anteriorly and that

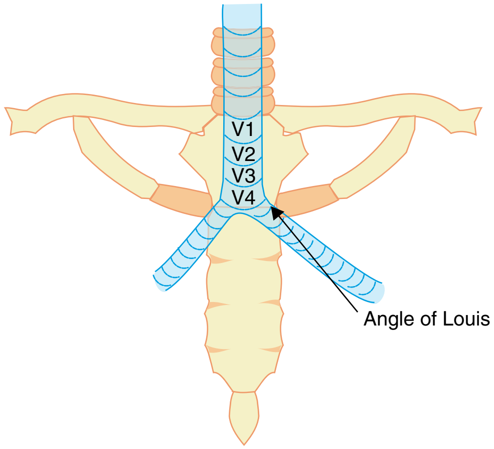


Figure 4.5 Trachea divides at the level of angle of Louis (anteriorly) and intervertebral disc between 4th and 5th spine posteriorly.

of lower lobe posteriorly. Middle lobe is mostly anterior (Fig. 4.6). The anterior border of left lung has a semicircular cardiac notch, which starts at the level of 4th costal cartilage, arcs laterally (for 2 cm) and joins the lower border at the 6th costal cartilage (this part of heart which is not covered by the left lung is the bare area of heart) (Fig. 4.7).

The lower border of lungs is at the level of 6th rib anteriorly in the midclavicular line, 8th rib in the midaxillary line and 10th rib posteriorly. The corresponding lower borders of pleura are the 8th, 10th and 12th ribs.

Examination of chest (Box 4.8)

Inspection – The patient is asked to strip his clothes up to the waist, and the examination is carried out under good light. In the case of females, the breasts should preferably be covered.

Shape of the chest can be examined with the patient in standing position or sitting on a stool (posterior and lateral examination) and in the supine position without a pillow for anterior examination from either the head or the foot end of the bed. In a patient who cannot sit, the back is examined by asking the patient to roll over to each side.

1. **Shape of chest** – Chest is broad and short in stocky individuals, and long and narrow in thinly built individuals. In elderly due to kyphosis, the AP diameter is increased (Fig. 4.8).

   Normal chest is symmetrical and ellipsoidal in shape, with its transverse diameter greater than its anteroposterior (AP) diameter (ratio 7:5). The subcostal angle is less than 90°.
2. **Chest deformities (**Figs. 4.8 (A) and 4.8 (B)**) are –**
   a. **Barrel-shaped chest** – It is seen typically in emphysema (hyperinflated lungs). The AP diameter is greater than the transverse diameter, the ribs are more horizontal, sternal angle is prominent and subcostal angle is wider (greater than 90°). The spine is more kyphotic.
   b. **Pigeon-breast chest (pectus carinatum)** – Upper part of sternum bulges forwards and is unduly prominent. In cross section, thoracic cage appears triangular. The deformity is due to childhood rickets.
   c. **Rickety chest** – The parasternal region on either side is depressed, often accompanied by bead-like enlargement of costochondral junctions resembling rosary (therefore called rickety rosary) and a transverse groove stretching from xiphisternum to the midaxillary line (Harrison's sulcus) corresponding to the attachment of diaphragm. The sulcus, especially associated with asthma or recurrent lung infections is due to the pull of diaphragm, on soft rickety bones during childhood.
   d. **Scorbutic rosary** is characterized by sharp angulation with or without beading (rosary of the ribs due to backward displacement of sternum). It is seen in scurvy.

Inspection of chest – points to be noted **Box 4.8**

- Shape of the chest (deformities)
- Symmetry
- Movements with breathing
- Respiration
  - ❒ Rate, rhythm
  - ❒ Depth, effort
- Type – abdominal, thoracic, thoraco-abdominal
- Audible sounds (wheeze, stridor)
- Positions of trachea and cardiac apex
- Dilated veins

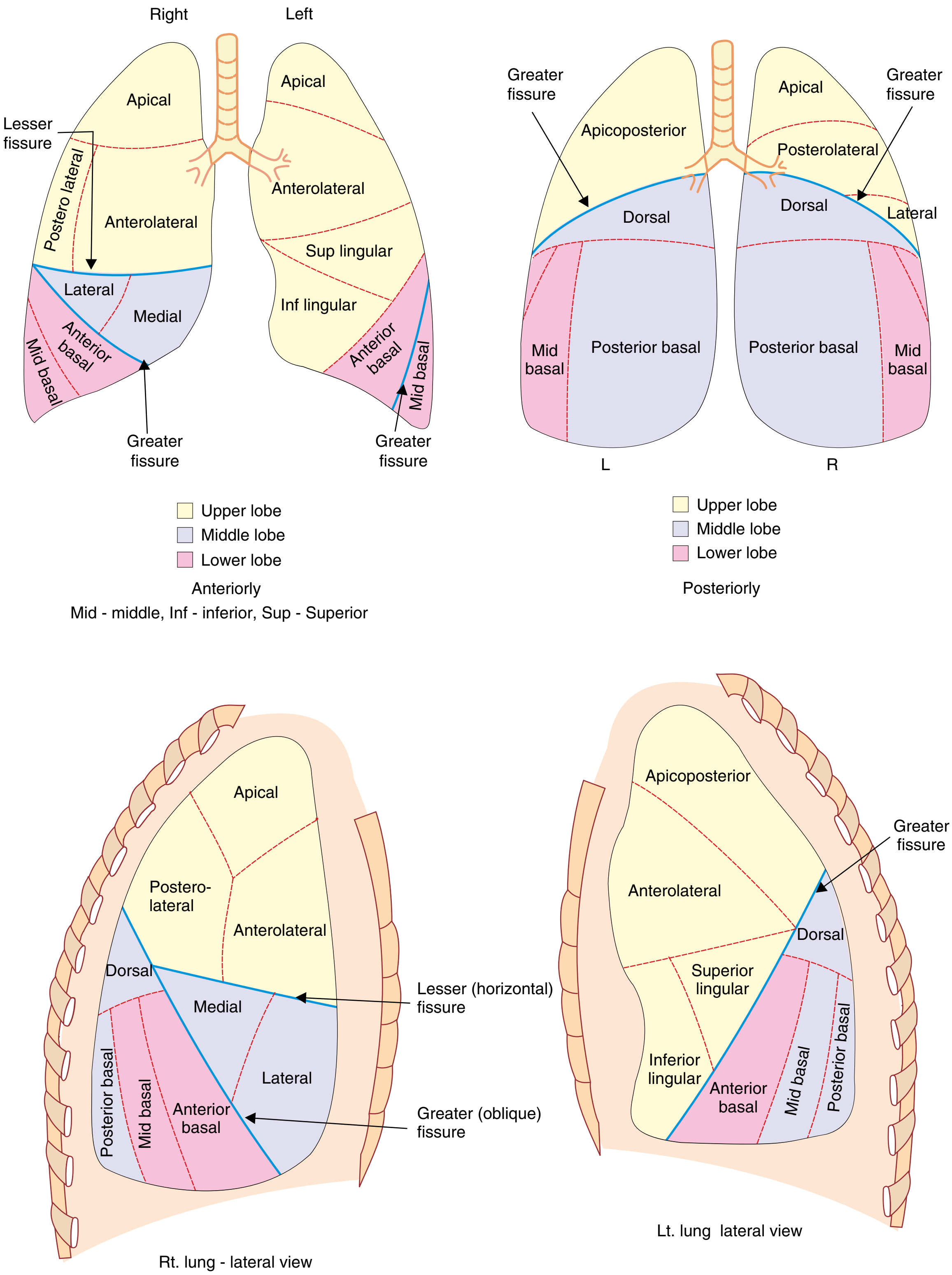

Right
Left
Apical
Lesser fissure
Postero lateral
Anterolateral
Lateral
Medial
Anterior basal
Mid basal
Greater fissure
Apical
Anterolateral
Sup lingular
Inf lingular
Anterior basal
Mid basal
Greater fissure
Upper lobe
Middle lobe
Lower lobe
Anteriorly
Mid - middle, Inf - inferior, Sup - Superior
Greater fissure
Apicoposterior
Dorsal
Mid basal
Posterior basal
L
Apical
Greater fissure
Posterolateral
Dorsal
Lateral
Posterior basal
Mid basal
R
Upper lobe
Middle lobe
Lower lobe
Posteriorly
Apical
Postero-lateral
Anterolateral
Dorsal
Medial
Lesser (horizontal) fissure
Lateral
Posterior basal
Mid basal
Anterior basal
Greater (oblique) fissure
Rt. lung - lateral view
Apicoposterior
Greater fissure
Anterolateral
Dorsal
Superior lingular
Inferior lingular
Anterior basal
Mid basal
Posterior basal
Lt. lung lateral view

Figure 4.6 Segments of lung.

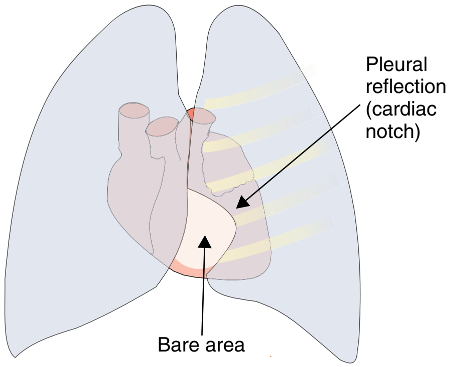

Pleural
reflection
(cardiac
notch)
Bare area

Figure 4.7 Bare area of heart (see superficial cardiac dullness).

e. **Saucer- or funnel-shaped chest (pectus excavatum)** – There is a depression (shallow or deep funnel-shaped) in the lower part of sternum. This may be occupational (e.g. cobbler), congenital or due to rickets. The heart gets compressed and on plain X-ray of the chest, heart may look (falsely) enlarged.

f. **Flat chest** – This is the opposite of barrel-shaped chest. The AP diameter is reduced. The scapulae may be prominent. This deformity is usually seen in bilateral pulmonary tuberculosis but may be the result of childhood rickets.

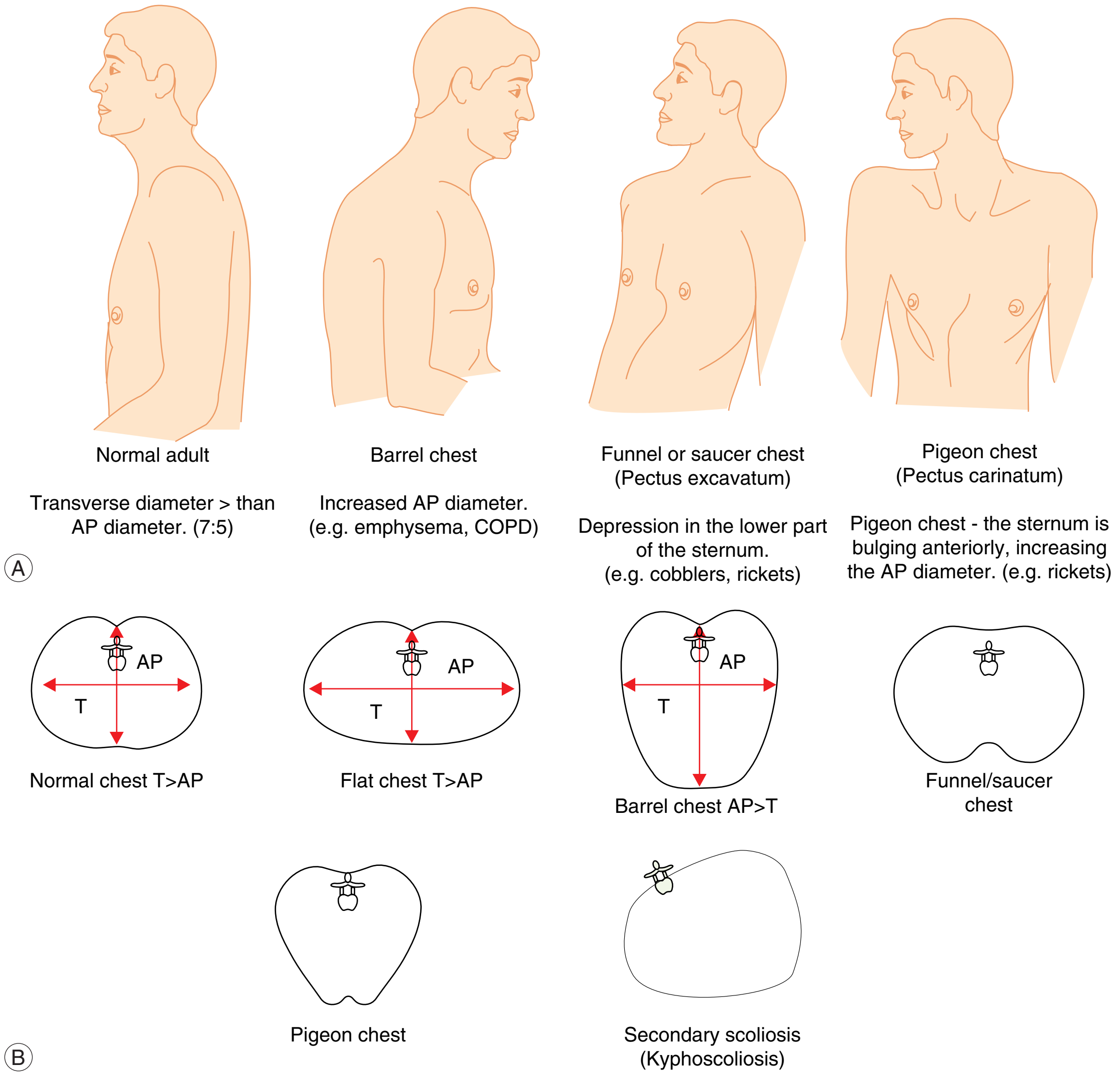

Normal adult
Transverse diameter > than AP diameter. (7:5)
Barrel chest
Increased AP diameter. (e.g. emphysema, COPD)
Funnel or saucer chest (Pectus excavatum)
Depression in the lower part of the sternum. (e.g. cobblers, rickets)
Pigeon chest (Pectus carinatum)
Pigeon chest - the sternum is bulging anteriorly, increasing the AP diameter. (e.g. rickets)
A
AP
T
Normal chest T>AP
AP
T
Flat chest T>AP
AP
T
Barrel chest AP>T
Funnel/saucer chest
Pigeon chest
Secondary scoliosis (Kyphoscoliosis)
B

Figure 4.8 (A) Various clinical appearances of chest. (B) Cross section of thorax showing chest deformities.

g. Localized bulging or localized depression of the chest is best detected by inspection of the chest from the foot end of the bed. It is seen as asymmetry due to retraction or prominence of one side or a region of the chest. To determine whether bulging or retraction is abnormal, note movements with respiration which are reduced on the abnormal side.

- Unilateral prominence of chest is usually due to a large pleural effusion, tension pneumothorax and pleural tumor (mesothelioma).
- Marked asymmetry of the chest is usually due to retraction of one side and only occasionally due to bulging (e.g. secondary to primary scoliosis).
- Localized bulging is noticed in pleural effusion, pneumothorax, cardiac enlargement, pericardial effusion, aneurysm of aorta, tumor, liver abscess, scoliosis, malignant tumor involving chest wall and rarely a pointing encysted empyema.
- Depression is due to fibrosis, collapse, thickened pleura and postlobectomy or pneumonectomy. The intercostal spaces (ICSs) are narrowed, and the subcostal angle on the affected side is narrow. There is drooping of shoulder of the same side.

h. Spine deformities

- **Straight back** results from the absence of normal thoracic kyphosis. This pushes the heart forwards with apparent enlargement of the heart silhoutte on plain X-ray of chest. Often, there is a functional pulmonary systolic murmur.
- **Scoliosis** (lateral curvature of spine) may be primary due to developmental structural defects of vertebrae or secondary to neuromuscular diseases, or secondary to unilateral pleuro-pulmonary pathology. Primary scoliosis causes asymmetry of chest, making comparison of the two sides misleading. There is increased posterior curvature of thoracic spine on the side of scoliosis with anterior prominence of the diagonally opposite side of chest.
- **Kyphosis** (see Fig. 1.44) is increased posterior curvature of spine. Causes of kyphosis are
  - Developmental
  - Emphysema
  - Pott's spine
  - Osteoporosis
  - Vertebral fractures
  - Scheuremann's disease

  The term *kyphoscoliosis* is used to describe combined deformity.

3. **Movements of chest** – Movements of chest are assessed by inspection either from the foot end of the bed or from the sides with the eyes parallel to the chest wall to note whether both the sides of chest are moving equally. Normally, both sides move equally and simultaneously (without lag), and the accessory muscles of respiration are not working. A normal person is comfortable in supine position.

   Diminished movement of chest on one side or of a localized region(s) is due to underlying lung or pleural pathology such as consolidation, collapse, lung fibrosis, pleural effusion, pneumothorax, empyema and thickened pleura. Diminished movement of chest on both the sides is commonly seen in emphysema and bronchial asthma, and rarely with bilateral fibrosis, pneumothorax or collapse. In ankylosing spondylitis, there is decreased chest expansion.

   Accessory muscles of respiration (sternomastoids, scaleni, trapezii, alae nasi) come into play in severe dyspnea, e.g. status asthmaticus, bronchopneumonia, massive lobar pneumonia and massive pleural effusion. Intercostal indrawing indicates increased intrathoracic negative pressure. It is most commonly associated with obstructive airways disease. Indrawing of lower costal margins during inspiration is a sign of respiratory distress.

4. **Respiratory rate** – Normal respiratory rate in adults is 15–20 per minute. Normal respiration to pulse ratio is 1:4. Tachypnea, i.e. increased rate of respiration (greater than 20 per minute) is seen with anxiety, pain (e.g. acute pleurisy) and chest diseases such as pneumonia, acute respiratory distress syndrome, pulmonary embolism and in left ventricular failure. In metabolic acidosis, respiration is rapid and deep (to wash out CO_2) (Kussmaul's respiration). The other causes of tachypnea are fever, exertion,

brain stem lesions and hysteria (when there is respiratory alkalosis and sometimes tetany).

In acute respiratory diseases (pneumonia, bronchopneumonia), the pulse:respiration ratio is altered as the respiratory rate increases more than the pulse rate. In patients with increased intracranial pressure (brain tumor), both pulse and respiratory rates are decreased. In opium poisoning, respiration is slow. Other causes of slow rate of respiration are alkalosis and hypothyroidism.

5. **Type of breathing** – Normally in men, breathing is mostly abdomino-thoracic, whereas in women, it is thoraco-abdominal. In abdominal diseases (e.g. peritonitis, gross ascites and paralysis of diaphragm), breathing is predominantly thoracic, and in chest diseases (e.g. collapse of lung, pleurisy), breathing is predominantly abdominal.
6. **Abnormal breathing** – Normal breathing is regular, inspiration being longer than expiration (Fig. 1.13).
    a. **Cheyne–Stokes breathing** – It is characterized by alternating periods of apnea and hyperpnea. It is due to anoxemia. Anoxemia causes cessation of breathing (due to depression of respiratory center), resulting in CO_2 retention that stimulates the respiratory center with hyperpnea and CO_2 washout. Loss of CO_2 causes depression of respiratory center, leading to apnea and thus the cycles of apnea and hyperpnea are repeated. Causes of Cheyne–Stokes breathing are increased intracranial pressure, severe left ventricular failure, narcotic poisoning and renal failure.
    b. **Biot's irregular breathing (ataxic breathing)** – This chaotic, irregular breathing is encountered in raised intracranial pressure.
    c. **Kussmaul's respiration** – Kussmaul's (air hunger) respiration resembles panting with deep and fast breathing. It is typically seen in ketoacidosis (diabetic, alcoholic) and severe renal failure.
    d. **Stertorous breathing** – Stertorous breathing is seen with deep coma and in dying patients. It is characterized by noisy breathing due to rattling sounds produced in the throat.
7. **Mediastinal position** – On inspection, one can get a clue regarding mediastinal shift by noting the positions of apex beat and trachea. Lower part of sternomastoid looks prominent on the side of tracheal deviation (**Trail's sign**).
8. **Chest veins** – Prominent chest veins with flow from above downwards are seen with superior vena cava (SVC) obstruction. In females with multiple pregnancies, chest veins are prominent. Chest wall edema is seen with empyema, liver abscess and lymphatic obstruction.

Palpation of chest

The findings of inspection are first confirmed. Anteroposterior and lateral diameters of the chest are measured, using calipers or with the aid of cardboards. Cardboards are placed on anterior and posterior walls of chest and the distance between the two measures AP diameter. Distance between cardboards placed parallel along lateral chest walls measures transverse diameter of chest. Normally ratio of AP:transverse diameters is 5:7. The abnormalities of shape of the chest have been described under inspection.

The movements of chest are next examined by placing both the hands with fingers spread out over right and left side of chest with the thumb tips meeting at midsternal line for examining front and at midvertebral line for examining the back of chest. For infraclavicular and pectoral areas, hands are below the clavicles in parallel on either side of sternum. Hands should be placed symmetrically on the both sides over all regions of the chest while the patient is breathing to detect any diminution or lag of movement.

The position of apex beat is noted to confirm the position of mediastinum (central or shifted). Conditions such as unilateral pleural effusion, pneumothorax and hydropneumothorax and tumors push the mediastinum to the opposite side, while pleural thickening, lung collapse and lung fibrosis pull the mediastinum to the same side. Nonpulmonary causes of shift of apex impulse are scoliosis, funnel-shaped chest, straight back syndrome and cardiac disorders.

Position of cardiac apex

Place the palm of right hand over left mammary region and feel the cardiac impulse, then localize the apex beat with the tip of middle finger and ascertain whether it is 1 cm inside the left midclavicular line in the 5th ICS (normal position) or whether it is shifted.

Position of trachea

Ask patient to slightly flex his neck while keeping the chin in the midline.

Place the index finger over suprasternal notch and feel gently, move the tip of finger on either side to ascertain the space between lateral borders of trachea and tendons of sternomastoid muscles on either side. The space is equal with centrally placed trachea. Deviation of trachea reduces the space on the side of deviation (Fig. 4.9). Tracheal shift is more marked in pathologies affecting upper lobe or superior mediastinum, whereas shift of apex beat is seen with lower chest pathologies.

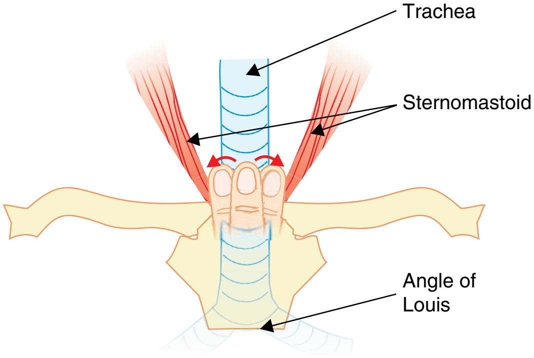


Figure 4.9 Palpation of trachea.

Tactile fremitus

Friction rub (acute dry pleurisy or resolving pleurisy), coarse crackles (bronchiectasis) and rhonchi (bronchial asthma) may be palpable. In acute pleurisy, the pain often restricts chest expansion of the affected area; hence, pleural fremitus may not be felt.

Tactile vocal fremitus

The patient is asked to say 99 or one, two, three loudly, and the vibrations are felt with the palmar surface of hand (preferably ulnar side) placed over the chest wall. Corresponding regions of the chest on either side should be compared to note the difference (more or less). Tactile vocal fremitus (TVF) is increased in consolidation and with solid tumors placed close to chest wall and in contact with a bronchus. Tactile vocal fremitus is decreased in collapse, fibrosis, emphysema, pleural effusion, pneumothorax and empyema.

During palpation, one may be able to elicit tenderness (Box 4.9).

Subcutaneous emphysema (Fig. 4.10) has a crepitant feel. Its causes are penetrating chest injury, tracheostomy, pneumothorax or esophageal rupture (rarely free air from abdominal cavity ascends up the mediastinum and is palpated over the neck).

Localized chest wall tenderness **Box 4.9**

- Costochondral joints – Tietz's syndrome
- Muscles – Injury, inflammation
- Intercostal spaces – Empyema, amebic liver abscess
- Bornholm disease
- Ribs – Secondaries, fractures, osteomalacia, osteoporosis (due to fractures), osteomyelitis
- Skin/subcutaneous tissue – Pyogenic abscess

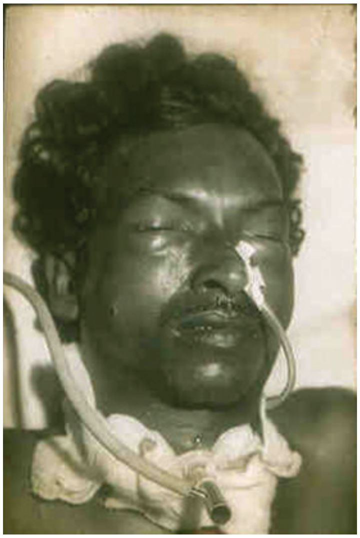


Figure 4.10 Subcutaneous emphysema (following to tracheostomy).

Percussion

For percussion, the pleximeter finger should be placed parallel to ribs (between the rib spaces) and not across the ribs. Corresponding areas of lung should be percussed successively and the notes compared.

Though generally the anterior part of chest is percussed with patient in supine position, a better position for percussion is sitting position with the patient's arms hanging by the sides for anterior percussion, with arms held over the head for lateral percussion and with hands across the chest holding opposite shoulders and patient bending forward for back percussion.

For heavy percussion, chest is percussed directly with fingers (usually to elicit stony dullness). Percussion note over normal lungs is resonant due to underlying air-filled alveolar sacs except for the area of superficial cardiac dullness (parasternal left 4th and 5th ICS about 1.5 cm lateral to left lateral sternal border). In lung diseases, the percussion note varies according to the pathology. Percussion note is graded as –

- Resonant (normal)
- Hyperresonant (emphysema, pneumothorax)
- Tympanic (tension pneumothorax, superficial cavity without fluid, Traube's space)
- Skodaic resonance (tympanic note elicited over relaxed lung above the level of pleural effusion)
- Impaired note (early consolidation, partial collapse, infiltration, fibrosis)
- Dull note (consolidation, complete collapse, massive fibrosis, thickened pleura)
- Stony dull note (pleural effusion, solid tumors)

Krönig's isthmus

If one percusses from the tip of the shoulder to the side of neck, one should be able to reveal a band of resonance (Krönig's isthmus) corresponding to the apex of lung. In diseases of upper lobe (tuberculosis, fibrosis), this band of resonance is diminished or obliterated. Direct percussion over clavicles gives the same information.

Liver dullness

One should always define upper border of liver dullness. Normally, it is present in the 5th ICS, in the right midclavicular line. Liver dullness is shifted down in emphysema, obliterated in pneumothorax, subdiaphragmatic air due to rupture of a hollow abdominal viscus and interposition of colon between liver and diaphragm. Upper border of liver dullness cannot be made out in the presence of pleural effusion. In amebic or pyogenic abscess of right lobe of liver, liver dullness may be shifted upwards. Collapse of right lung also shifts upwards the upper border of liver dullness.

Cardiac dullness

One can roughly demarcate the left border of heart by percussing in the left 3rd, 4th and 5th ICSs, starting from anterior axillary line and moving medially towards sternum. Normally, heart dullness starts in the 3rd and 4th ICSs in the left parasternal region inside the left midclavicular line in the 5th ICS. This is termed *deep cardiac dullness* as against superficial cardiac dullnesses elicited by very light percussion over the bare area of heart (corresponding to surface marking of cardiac notch of left lung), i.e. 4th and 5th ICS about 1.5 cm lateral to left lateral sternal border. Superficial cardiac dullness is masked in emphysema (Fig. 4.7). In left-side pneumothorax, both deep and superficial cardiac dullnesses are masked.

It may be difficult to percuss heart borders in obese individuals. If cardiac dullness cannot be elicited on the left side for no obvious reason, one must exclude dextrocardia.

Traube's space

Traube's space overlies the fundus of stomach. It is a trapezoid-shaped area with upper margin demarcated by the left leaf of diaphragm (resonance of normal lung), right border by the left lobe of liver, left border by spleen and lower border by the left costal margin. Presence of gas in the fundus of stomach causes the tympanic percussion note over the space (Fig. 4.11).

Causes of loss of Traube's space resonance

- Left-side pleural effusion
- Enlarged left lobe of liver
- Massively enlarged spleen
- Growth in the fundus of stomach (the space may be obliterated with full stomach)
- Large pericardial effusion

In collapse of left lung, paralysis of left dome of diaphragm, and marked pulmonary fibrosis, Traube's space shifts upwards.

Direct percussion over sternum may be useful to detect retrosternal goiter and herniation of one lung to the opposite side. Percussion tenderness over sternum should alert one to the possibility of leukemia. Tenderness to percussion of ICSs is present in empyema and liver abscess.

Upper border of pleural effusion assumes an "S" shape with the highest point in the axilla and the lower positions posteriorly and anteriorly ("S" shape of Ellis). In hydropneumothorax in sitting position, the upper border is horizontal and parallel to the bed.

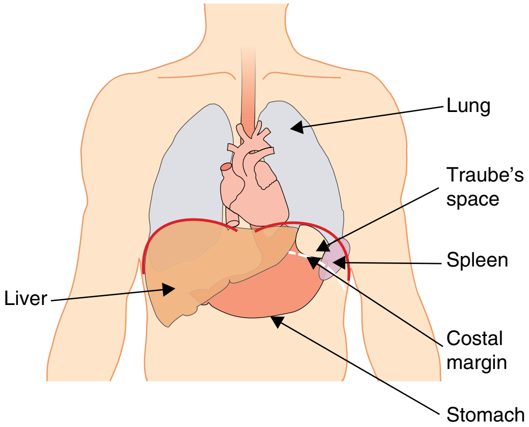


Figure 4.11 Traube's space.

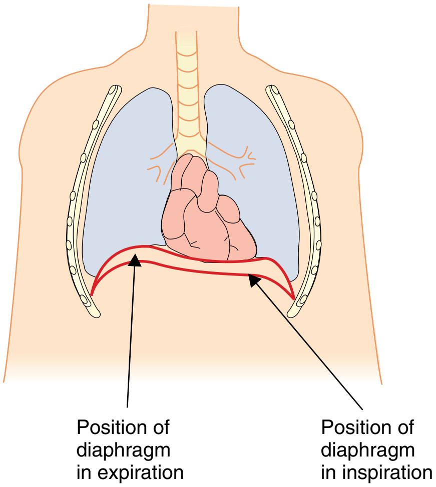

Position of diaphragm in expiration
Position of diaphragm in inspiration

Figure 4.12 Excursions of diaphragm during inspiration and expiration (see tidal percussion).

In earlier days, when imaging facilities were not always available, tidal percussion was useful. The lower border of the lung is first determined during expiration. With deep inspiration, the lower border shifts down by 4–5 cm (2 ICS). This is due to downward excursion of diaphragm (Fig. 4.12). The causes of diminished tidal percussion (excursion of lung) are diseases involving base of lung or pleura or pathologies involving upper surface of liver and subdiaphragmatic space, e.g. abscess.

The lower border of lung shifts down in emphysema and acute asthmatic attack. It shifts up with collapse of lung.

Shifting dullness can be elicited in the presence of hydropneumothorax. In sitting position, there is dull note in mammary area, which becomes resonant when patient assumes supine position as the air shifts anteriorly and fluid settles posteriorly.

Myotatic irritability elicited on direct tapping of muscle is seen with cachexia.

Auscultation

Diaphragm of the chest piece should preferably be used for auscultation of lungs. The patient is asked to breathe in and out through the open mouth. Points to ascertain are intensity of breath sounds (air entry), type of breath sounds, vocal resonance (VR) and adventitious sounds. One should successively auscultate the corresponding regions, alternately on the two sides. All the areas of the chest except scapular area should be auscultated (Box 4.10).

Auscultation – points to be noted **Box 4.10**

- Air entry (intensity of breath sounds)
- Character of breath sounds
- Adventitious sounds
- Vocal resonance
- Specific maneuvers

While listening to breath sounds, quality (type) and intensity (loudness) of breath sounds are noted. In children and females and in persons with thin chest wall, breath sounds are loud, whereas in persons with thick chest wall, in obese individuals and in emphysema, breath sounds are diminished in intensity. The breath sounds may be absent (Box 4.11).

Causes of absent breath sound **Box 4.11**

- Pleural effusion
- Closed pneumothorax
- Collapse of lung with occluded bronchus
- Tumor
- Pneumonectomy/lobectomy

Causes of diminished intensity of breath sounds

- Normal individuals – Thick chest wall, obese individuals
- Pathological – Emphysema, acute attack of bronchial asthma, thickened pleura, pulmonary fibrosis, collapse of lung

1. **Types of breath sounds**
    a. **Normal vesicular breathing** – It is characterized by active inspiration, which is heard all through as the air enters the lungs. The inspiratory murmur has a rustling quality (much like gentle wind blowing through trees). It is followed without any pause by passive expiratory murmur, which is due to elastic recoil of alveoli and is heard only during the initial phase of expiration. Overall, the character of breath sounds is rustling. The normal ratio of inspiratory to expiratory phase is 3:1. Normally, inspiration is an active process, whereas expiration is a passive process (Fig. 4.13).

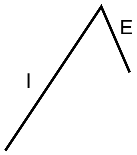


Figure 4.13 Normal vesicular breathing: E is 1/3rd of I, no pause, rustling character.

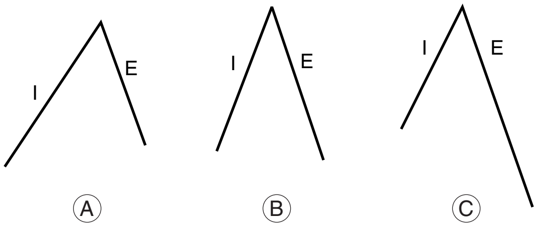


Figure 4.14 Vesicular breathing with prolonged expiration, no pause, harsh character. (A) E prolonged but less than 1. (B) E prolonged and equal to 1. (C) E prolonged and greater than 1.

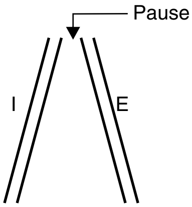


Figure 4.15 Bronchial breathing I = E, pause, hollow character.

b. **Vesicular breathing with prolonged expiration (harsh vesicular breathing)** – Inspiration is active and heard throughout, but expiration is also active and prolonged due to airway obstruction due to bronchospasm or mucus. Expiratory phase may be a little shorter than inspiration, or equal to inspiration or even longer than inspiration. There is no pause between inspiration and expiration because alveolar phase is unaffected (Fig. 4.14). (This breathing is quite often mistaken for bronchial breathing because expiration is prolonged and harsh.) Emphysema, chronic bronchitis and asthma have prolonged expiration. (In severe cases, patient expires with pursed lips to aid effective expiration.)

c. **Bronchial breathing** – Here, both inspiration and expiration are active, and there is a pause because of loss of alveolar phase of inspiration (Fig. 4.15). The most important (and essential) characteristic of bronchial breathing is the hollow (bronchial) character of expiratory breath sounds. Bronchial breath sounds can be heard normally over trachea and over larger bronchi. Depending upon the pitch, bronchial breathing is classified into following three categories.

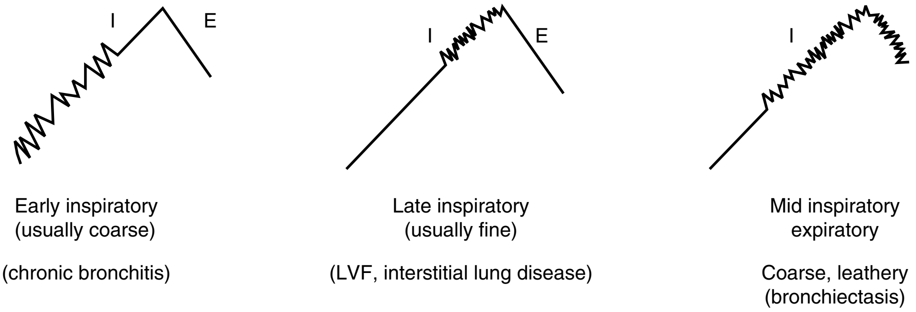
   i. **Tubular** or high pitched, heard typically over consolidation.

   ii. **Cavernous** or low pitched, heard typically over cavity communicating with a bronchus.

   iii. **Amphoric** a low pitched breathing but with overlapping high pitched sounds. It has a hollow reverberating quality. It is heard over open pneumothorax or a large cavity communicating with a bronchus. (The character of bronchial breathing over a cavity is the function of its size in relation to the bronchus opening into it and the smoothness or otherwise of its walls. When the cavity is relatively large and has a smooth wall, the breathing assumes an amphoric character.)

2. **Adventitious sounds** – Recently, it is recommended to describe adventitious sounds either as crackles (moist sounds) or wheezes (dry sounds). Older terms *rales* (coarse crackles), *crepitations* (fine crackles) and *rhonchi* (wheezes) are, therefore, not much in use.

   a. **Crackles** – These are short, explosive, clicking or bubbling sounds heard mostly during inspiration. In a person with hairy chest, friction with hair can produce sounds that can be mistaken for crepitations. It is suggested to moisten the hair and apply the chest piece firmly to the chest wall. The loudness and character of crackles depends upon the site of pathology (whether deep or superficial) and the consistency of secretions respectively. Fine crackles (heard at the end of inspiration) suggest alveolar pathology (e.g. pulmonary tuberculosis, pulmonary congestion, interstitial lung disease [ILD], sarcoidosis). Early inspiratory crackles denote collection of secretions in bronchi (e.g. chronic bronchitis, bronchiectasis). Expiratory crackles are present in chronic bronchitis



Early inspiratory
(usually coarse)

(chronic bronchitis)

Late inspiratory
(usually fine)

(LVF, interstitial lung disease)

Mid inspiratory
expiratory

Coarse, leathery
(bronchiectasis)

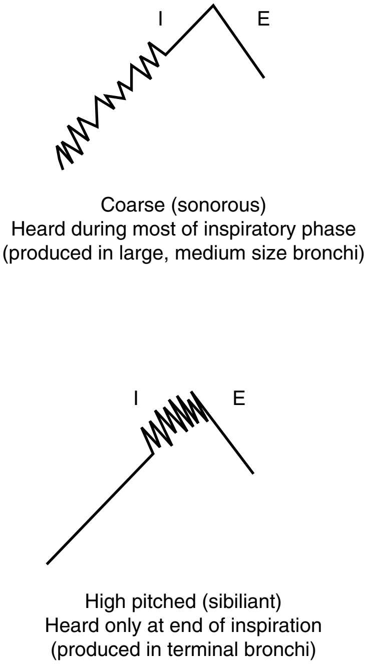
Figure 4.16 Crepitations or crackles (moist sounds).

and pulmonary edema. Coarse crackles are heard over bronchiectasis (often described as leathery) and lung abscess. Bubbling crackles are heard in pulmonary edema, Velcro crackles in interstitial pulmonary fibrosis and fine crackles over lung bases in left ventricular failure (Fig. 4.16).

Crackles that clear on coughing are not significant (are due to hypostatic congestion). These are usually heard at the lung bases. Crackles when present along with dry cough are due to ILD, while cough with sputum production suggests parenchymal disease.

Post-tussive crackles – One should always reauscultate after asking the patient to cough. Cough dislodges the thick secretions and one then hears the crackles, termed *post-tussive crackles*. Post-tussive crackles in apical areas of the lung are heard in tuberculosis.

b. Wheezes – These have musical or whistling character and are produced by the flow of air through narrowed bronchi. Coarse wheezes (sonorous) are due to pathology in large- and medium-sized bronchi and are heard during most of the inspiratory phase, whereas high pitched wheezes (sibilant) are heard only at the end of inspiration as air passes through the narrowed terminal bronchi. (This distinction of site of bronchial narrowing based on character of rhonchi is not absolute.) Absence of rhonchi in a patient with a severe asthmatic attack is a grave sign. A single, persistent, localized rhonchus is a feature of localized bronchial obstruction, e.g. endobronchial growth, bronchostenosis or foreign body.



Coarse (sonorous)
Heard during most of inspiratory phase
(produced in large, medium size bronchi)

High pitched (sibiliant)
Heard only at end of inspiration
(produced in terminal bronchi)

Figure 4.17 Wheezes or rhonchi (dry sounds).

Expiratory wheeze can often be brought out by asking the patient to breathe out forcibly through pursed lips (Fig. 4.17).

c. Stridor – It is a loud inspiratory sound heard during inspiration due to obstruction either in larynx (laryngeal stridor) or in trachea (tracheal stridor). The obstruction can be due to a foreign body, diphtheritic membrane or tumor. It is an emergency situation (Fig. 4.18).

d. Mediastinal crunch (Hamman's sign) – It is a rhythmic, clicking sound, heard synchronously with cardiac cycle (heard even after asking patient to hold breath). It is best

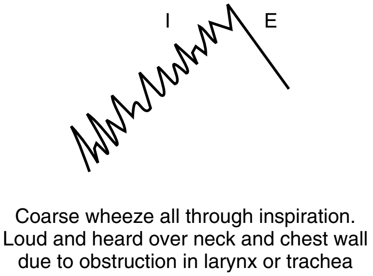

I
E
Coarse wheeze all through inspiration.
Loud and heard over neck and chest wall
due to obstruction in larynx or trachea

Figure 4.18 Stridor.

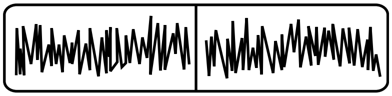


Figure 4.19 Mediastinal crunch.

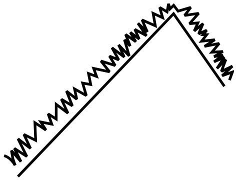


Figure 4.20 Pleural rub.

Table 4.1 Differences between pleural rub and coarse crackles

Coarse crackles	Pleural rub
• Short, explosive, clicking	• Creaking, leathery
• Interrupted sound	• To-and-fro sequence during inspiration and expiration
• Do not accentuate with increased pressure of chest piece against the chest wall	• Accentuated with increased chest piece pressure against the chest wall
• Usually heard over a wide area	• Usually heard over a localized area
• Not accompanied by pain and tenderness	• Local pain and tenderness present in acute pleurisy
• Altered by coughing	• No change on coughing

heard with the patient in left lateral position. It denotes mediastinal emphysema (Fig. 4.19).

e. Pleural rub – It is a sign of pleural pathology. Pleural rub is heard in both phases of respiration, has a fixed location and phase of respiration. It has a harsh, creaking quality and is not affected by coughing. It is heard in acute dry fibrinous pleurisy (due to rubbing of rough pleural surfaces as a result of inflammation), or in resolving pleurisy with effusion due to thickening of pleura. Pleural rub in acute dry pleurisy causes pain; hence, patient restricts his breathing, and therefore the rub is heard for only a short phase of breathing or may even be absent. In resolving pleurisy, the rub is heard all through inspiration and expiration (to-and-fro sequence) and is painless as there is little or no inflammation. Pleural rub becomes louder with increased pressure of the chest piece against the chest wall. Coarse crackles that may sometimes be mistaken for pleural rub do not alter with increased pressure of chest piece. Further, pleural rub is usually heard over localized area and does not alter or shift with coughing, whereas crackles may alter with coughing as coughing displaces the secretions (Fig. 4.20; Table 4.1).

f. Pleuropericardial rub – It is heard in pleurisy due to friction between pleura and pericardium and is the result of cardiac contractions.

g. Succussion splash – The splash is typically heard either with ear kept directly near the chest wall or with a stethoscope when patient is shaken. It is heard in hydropneumothorax and rarely in large cavity containing air and thin fluid and over fundus of stomach filled with air and fluid. To elicit the splash, patient is asked to lie in lateral position with the healthy side down. The air–fluid level position is determined and chest piece kept at that level. A splash is heard on vigorous shaking of the patient. Splash can also be elicited with the patient in an upright position. The air fluid level is determined and the chest piece is kept at that level.

3. Vocal resonance – Patient is asked to say 99 or 1, 2, 3, and the intensity of the sound is checked on either side. Vocal resonance is increased in consolidation and in a communicating thick walled cavity. Vocal resonance is decreased or absent in emphysema, fibrosis, lung collapse, thickened pleura, pleurisy with effusion and closed pneumothorax. In bronchophony, the sounds appear to be spoken directly in one's ears and not at the chest piece.

Egophony – The vocal sounds (e.g. 99 or 1, 2, 3) have a nasal quality (like the bleating of a goat). It is typically heard over relaxed lung floating above the pleural effusion.

Whispering pectoriloquy – The patient is asked to whisper 99 or 1, 2, 3. If during auscultation, whispered words are heard with clarity as if whispered directly into one's ears, whispering pectoriloquy (WP) is present. Whispering pectoriloquy is heard over cavity communicating with a bronchus, over consolidation and open pneumothorax. Whispering pectoriloquy is a definite sign of underlying consolidation or cavity.

Post-tussive suction – Rarely, one may detect this sign over a superficial, thin-walled collapsible cavity communicating with a bronchus. After a bout of explosive coughing (that collapses the cavity) when patient breathes, air enters the cavity with a sucking sound.

Coin sound sign – The sign is elicited by striking a coin placed over the chest with another coin and auscultating on the opposite part of hemithorax in presence of pneumothorax. A metallic sound is heard over pneumothorax, particularly it is very loud in tension pneumothorax.

RELEVANT INVESTIGATIONS

1. **Sputum examination** – Sputum should be sent to laboratory for Gram stain, Ziehl Nelson stain (for acid-fast bacillus [AFB]) and culture sensitivity. In a patient with suspected lung carcinoma, sputum cytology must be checked.
2. **Pulmonary function tests** – Normal expiratory spirogram is shown in Fig. 4.21 and normal lung volumes are shown in Fig. 4.22.

   Vital capacity is the amount of air which can be exhaled (forced expiration) after a maximal inspiration. Usually, vital capacity is estimated with a spirometer by asking the patient to blow as hard and as fast as possible. This is termed *forced vital capacity* (FVC). The volume of air blown out in the first second of forced expiration is known as forced expiratory volume in 1 second (FEV$_1$). In healthy lungs, FEV$_1$ is at least 80% or more of FVC. In obstructive lung disease (COPD), the time taken to fully expire is prolonged; hence, FEV$_1$/FVC% is reduced. In contrast in restrictive lung disease, both FEV$_1$ and FVC are reduced in proportion to each other, so the ratio remains normal or even increased though the absolute values are reduced.

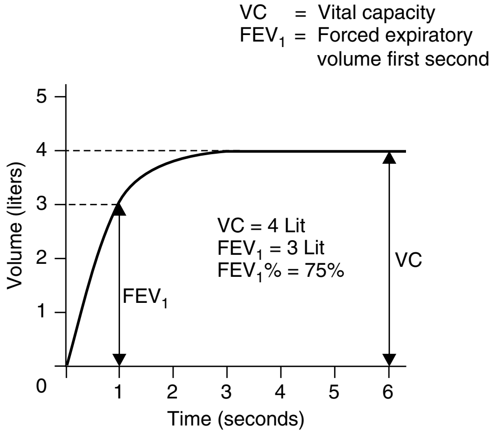


Figure 4.21 Normal expiratory spirogram.

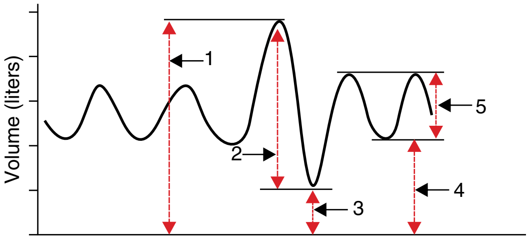


Figure 4.22 Lung volumes. 1 – total lung capacity, 2 – vital capacity, 3 – residual volume, 4 – functional residual capacity, 5 – tidal volume.

   In physician's office or patient's home, one may use peak flow meter. The rate of airflow during forced expiration is greatest during early part of expiration, and this can be measured as peak expiratory flow (PEF) rate with a peak flow meter. Patient can use it at home to monitor his progress while on bronchodilators. (Fig. 4.23 shows inspiratory and expiratory flow in normal individuals and in COPD.)
3. **Imaging** – It is described in more detail under clinical cases and radiology section.
   a. **Plain X-ray of chest (posteroanterior view)** – It should be taken as a routine in all cases. If previous X-ray chest is available, it should be compared.

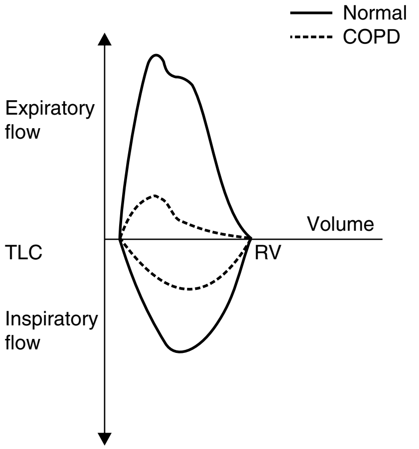


Figure 4.23 Inspiratory and expiratory flow in normal and COPD.

b. **Computed tomography scan (CT)** – It helps in the diagnosis of mediastinal tumors, lymphadenopathy, staging of bronchogenic carcinoma, bronchiectasis and interstitial pulmonary fibrosis. Computed tomography angiography is useful to diagnose pulmonary embolism.

c. **Magnetic resonance imaging (MRI)** – It is only in some situations that one asks for magnetic resonance imaging of chest to demonstrate mediastinal abnormalities and for diagnosis of pulmonary embolism.

d. **Ultrasonography** – It is useful to evaluate respiratory excursions of diaphragm on either side, in differentiating pleural fluid from pleural fibrosis (fluid can be seen moving). Diagnostic or therapeutic pleural fluid aspiration (especially with small effusions) is ideally performed under ultrasound guidance.

e. **Radioisotope imaging** – Both ventilation and perfusion scans of the lungs are performed with this technique. For ventilation scan a radioactive gas like krypton-81 m is inhaled and the distribution of radioactivity is scanned. Perfusion scan is obtained by intravenous injection of macroaggregated human albumin particles labeled with technetium-99 m. Then with the help of gamma camera, pulmonary vasculature is studied. Both ventilation and perfusion are equally diminished in diseased lung. This is "matched defect" as against "mismatched defect" seen in pulmonary embolism where ventilation is normal but perfusion is reduced.

f. **Positron emission tomography (PET)** – It is used to evaluate pulmonary nodules, mediastinal lymph nodes to diagnose recurrence and staging of lymphomas. The latest advancement combines CT-PET scanners.

4. **Pleural biopsy (see Chapter 12).**
5. **Bronchoscopy (see Chapter 12).**
6. **Lung biopsy** – Transthoracic lung biopsy is indicated in peripheral masses, nodules, mediastinal lymphnodes. It is usually CT-guided or Videoscopy assisted. Transbronchial biopsy is indicated in diffuse interstitial lung disease.
7. Bronchoalveolar lavage is indicated in lung infections and diffuse lung diseases.

CLINICAL CASES

A case of bronchial asthma

1. **Definition** – Bronchial asthma is characterized by inflammation of airways causing bronchospasm. It is precipitated by a variety of trigger factors. There is a variable reversibility of bronchospasm.
2. **Etiology** – Asthma is multifactorial, involving genetic susceptibility and environmental factors. It usually starts in childhood.
3. **Precipitating factors for bronchial asthma**
   a. Inhaled allergens – Pollen, mite, smoke, grain dust, wood dust, cockroaches, pets
   b. Food allergens – Fish, ajinomoto, nuts, sour fruits
   c. Drugs – Aspirin, NSAIDs, sulfa drugs, β-blockers
   d. Cigarette smoke, perfumes, cosmetics
   e. Rain, cold weather, snow
   f. Bacterial and viral infections
   g. Stress, exercise
   h. Occupation – Exposure to polluted atmosphere, toxic fumes, vapors.
4. **Clinical features**
   a. Asthma is clinically classified into four categories, based on symptom pattern and pulmonary function tests (PFTs).

   i. Mild intermittent
   ii. Mild persistent
   iii. Moderate persistent
   iv. Severe persistent

   A patient may remain stable in one category or shift from one to another. Status asthmaticus is severe and prolonged bronchospasm which is resistant to treatment.

- **b.** Patient usually presents with dyspnea, wheezing and cough, having episodic exacerbations and remissions. The attacks vary according to season (monsoon, winter, autumn). During an acute attack, orthopnea, restlessness and sweating are present. Patient prefers a sitting posture, leaning forward with the accessory muscles of respiration working (expiratory dyspnea). In between attacks, the symptoms and signs disappear.
- **c.** On examination, there is tachycardia, tachypnea, bronchospasm, prolonged expiration, rhonchi and crackles.
- **d.** During status asthmaticus, symptoms and signs are exaggerated. Patients have severe tachycardia, pulsus paradoxus, tachypnea, severe bronchospasm, hypoxia with or without cyanosis and mental obtundation. The chest may be silent (grave sign of severe airways obstruction).

5. Investigations

- **a.** Pulmonary function tests indicate reversible obstructive disease.
- **b.** Chest X-ray shows hyperinflated lungs in chronic cases, or during an attack and normal lung fields in mild cases. Look for complicating pneumothorax, which may be present.
- **c.** Blood gases in severe cases show respiratory and metabolic acidosis with hypercapnia and severe hypoxia (obstructive type).
- **d.** In children or adults with history suggestive of allergy, allergy test is carried out.

6. Principles of management

- **a.** Known allergens including food items and drugs should be avoided; house and workplace should be kept dust and smoke-free.
- **b.** For mild cases, inhalers (β-2 agonists, e.g. salbutamol) should be used.
- **c.** For moderate to severe cases and chronic asthma, combination of steroids and regular inhaled bronchodilators should be used. During acute attacks, nebulized bronchodilators should be used.
- **d.** Antibiotics are usually required as infection is a common precipitating factor.
- **e.** Sedatives should be avoided.
- **f.** Routine monitoring of the patient with PEF rate is useful.

Table 4.2 **Drugs used in bronchial asthma**

1. Beta agonists	
a. Short acting	Salbutamol, albuterol, bitolterol, levalbuterol, pirbuterol
b. Long acting	Formoterol, salmeterol
2. Anticholinergic	Ipratropium
3. Corticosteroids	
a. Inhaled	Beclomethasone, budesonide, fluticasone, flunisolide, triamcinolone
b. Systemic	Prednisolone, methylprednisolone
4. Combination drugs	Ipratropium + albuterol Fluticasone + salmeterol
5. Methylxanthine	Theophylline
6. Mast cell stabilizers	Cromolyn, nedocromil
7. Leukotriene inhibitors	Montelukast, zafirlukast, sileiton

Viva voce

Q1. How would you differentiate between intrinsic and extrinsic types of bronchial asthma?

Intrinsic (nonatopic)	Extrinsic (atopic)
Idiopathic	Allergic
No H/o allergy	H/o allergic dermatitis, rhinitis
Genetic predisposition (none)	Familial predisposition
Starts late in life	Starts in childhood
Normal IgE levels	Elevated IgE levels
Perennial symptoms	Seasonal or perennial symptoms
Responds to corticosteroids	Responds to corticosteroids

Q2. Does gastroesophageal reflux disease worsen bronchial asthma?

Yes, patients with gastroesophageal reflux disease become worse after meals due to gastroesophageal reflux. They should be given antireflux treatment.

Q3. What are the complications of acute bronchial asthma?

- Collapse of lung
- Pneumothorax
- Acute cor pulmonale
- Mediastinal emphysema
- Subcutaneous emphysema
- Respiratory failure

Q4. What is hygiene hypothesis for bronchial asthma?

It is believed that infants are born with predilection to TH2 responses (allergy and inflammation) with activation of eosinophils and IgE production. Bacterial and viral infections in neonates stimulate TH1 responses and thus tilt the balance away from TH2 response. This results in induction of tolerance. Thus, infants and children growing in cleaner environment and protected from infections do not undergo this change, which results in increased susceptibility to asthma in these children.

Q5. How will you manage a case of status asthmaticus?

- Hospitalize the patient (if home treatment fails, i.e. no response in 4 hours) and administer oxygen.
- Administer nebulized salbutamol 5 mg or terbutaline 10 mg in oxygen. Repeat in a few minutes if no response. In patients who are moribund, weak or coughing excessively, administer sc terbutaline 0.25–0.5 mg or epinephrine 1:1000 dilution (0.2–0.5 ml) sc in children and young adults, every 20 minutes.
- With no response to above, administer nebulized ipratropium bromide 0.5 mg plus salbutamol 5 mg or terbutaline 10 mg in oxygen.
- With no response to above, administer IV aminophylline as 5 mg/kg loading dose as an infusion (not to be given to those on aminophylline or who have received it before hospitalization).
- Corticosteroids – Hydrocortisone 200–500 mg is given intravenously every 4–6 hours in severe cases or oral prednisolone 40–60 mg loading dose and then 20 mg every 6 hours.
- All along, patient should be monitored continuously with pulse and respiratory rate, arterial blood gases and for distress.
- Antibiotics in the presence of infection.
- Intubation and mechanical ventilation with no response to above treatment, and when there is severe hypoxia, exhaustion, deteriorating mental status and cardiac or respiratory arrest.
  Note: Anxiolytics are contraindicated, as these are associated with increased mortality.

A case of chronic obstructive pulmonary diseases (COPD)

1. **Introduction** – COPD is an abnormal chronic inflammatory response to a variety of respiratory irritants, resulting in partially reversible airflow obstruction. It includes three conditions: (a) chronic bronchitis which is defined as having chronic productive cough lasting for at least 3 months in two successive years. (b) chronic bronchial asthma or chronic asthmatic bronchitis; the latter is seen in asthmatic smokers and (c) emphysema, which is permanent dilatation of air spaces beyond respiratory bronchioles with destruction of alveolar septa without fibrosis.
2. **Common etiological causes**
   - **a.** Smoking – the commonest cause, it also triggers asthmatic attack.
   - **b.** Polluted atmosphere – Industrial areas, homes using wood or cow dung for cooking.
   - **c.** Occupational hazards – Workers exposed to fumes, gases, chemicals, irritant vapors.
   - **d.** Recurrent infections – Bacterial (*Haemophilus influenzae*, *Pseudomonas aeruginosa*), viral infections.
   - **e.** Genetic – α-1 antitrypsin deficiency associated with emphysema (present in 5% of COPD cases).
3. **Clinical features**
   - **a.** Chronic bronchitis presents as cough with mucoid expectoration, which becomes purulent with secondary infection. Over time, patient develops persistent breathlessness. Fever is common. Patient gets attacks of bronchitis during monsoon or cold weather. With every attack, there is damage to lungs resulting in emphysema.

b. Patients with predominantly chronic bronchitis with centrilobular emphysema develop CO_2 retention and congestive cardiac failure (CCF) – the **blue bloaters**. Others with predominantly generalized emphysema maintain O_2 saturation – the **pink puffers** (Table 4.3).

c. Chest examination in chronic bronchitis reveals prolonged expiration, bilateral crackles and rhonchi, and in emphysema, there are signs of inflated chest (hyperresonant percussion note, liver dullness shifted downwards and superficial cardiac dullness masked) and prolonged expiration with decreased air entry on both sides.

Table 4.3 **Differences between pink puffers and blue bloaters**

Features	Pink puffers	Blue bloaters
Predominant lung condition	Emphysema	Chronic bronchitis
Predominant complaint	Breathlessness with scanty sputum	Cough with massive sputum
Respiratory failure	Last stage	Recurrent attacks
Congestive cardiac failure	Rare	Common
Blood gases	Normal till end	$CO_2 \uparrow$, $O_2 \downarrow$
Clinical signs	Emphysema	Chronic bronchitis

4. **Investigations**
   a. Blood – WBC count increased with infection, polycythemia may be present
   b. Chest X-ray
      i. Emphysema (Fig. 4.24)
         - ❑ Flat diaphragm, inflated chest
         - ❑ Narrow cardiac silhouette
         - ❑ Prominent hilar vessels (pulmonary arterial hypertension) with rapid tapering
         - ❑ Widening of retrosternal space (lateral view)
         - ❑ Lung interposed between diaphragm and inferior border of heart
         - ❑ Bullae (Fig. 4.25)
         - ❑ Predominant basal emphysema suggests α-1 anti-trypsin deficiency
      ii. In chronic bronchitis, X-ray shows increased bronchovascular markings

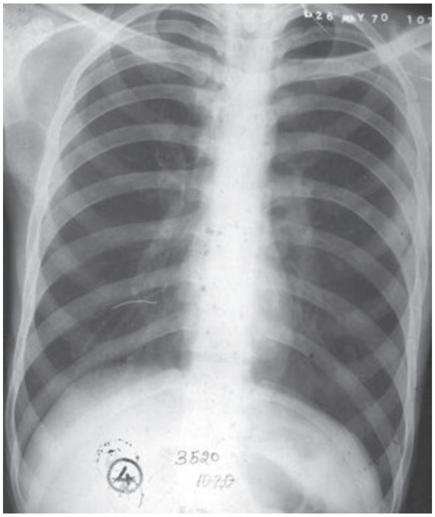


Figure 4.24 Emphysematous chest.

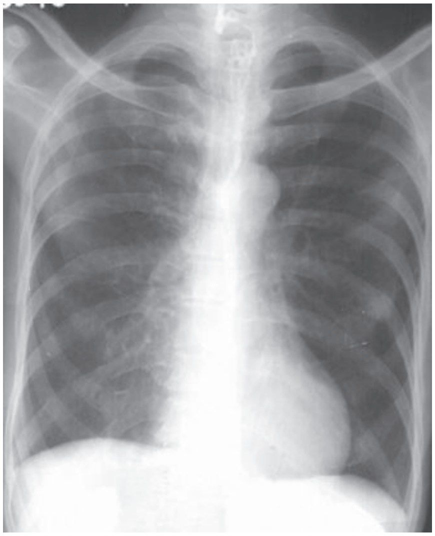


Figure 4.25 Chronic obstructive pulmonary disease with emphysematous bullae.

   c. Sputum – Mucoid, mucopurulent or purulent. Culture/sensitivity test should be done
   d. Electrocardiogram – Low voltage in emphysema; features of pulmonary arterial hypertension (prominent P wave, right ventricular hypertrophy; arrhythmias) may be present.
   e. Pulmonary function tests (Table 4.4)

Staging of COPD as per PFT –
- Stage I: FEV1 (greater than 50%, predicted);
- Stage II: FEV1 (35–50%, predicted);
- Stage III: FEV1 (less than 35%, predicted).

Table 4.4 **Lung function tests in obstructive and restrictive lung diseases**

Lung function test	COPD	Restrictive lung disease
VC	Slightly reduced	Markedly reduced
FEV_1	Markedly reduced	Reduced proportionate to VC
FEV_1/VC	Reduced	Normal or increased
PEF	Reduced	Normal
RV	Increased	Reduced
TLC	Increased	Reduced
PaO_2	Decreased	Decreased
$PaCO_2$	Increased	Normal or low
DLCO	Reduced	Reduced

VC, vital capacity; FEV_1, forced expiratory volume in 1 second; PEF, peak expiratory flow; RV, residual volume; TLC, total lung capacity; PaO_2, partial pressure of oxygen in arterial blood; $PaCO_2$, partial pressure of CO_2 in arterial blood; DLCO, diffusion capacity.

5. **Complications**
   - **a.** Chronic cor pulmonale (see Chapter 3)
   - **b.** Respiratory failure
   - **c.** Pneumothorax (rupture of bullae)
   - **d.** Increased incidence of lung cancer
   - **e.** Increased incidence of peptic ulcer
6. **Principles of management**
   - **a. Medical**
     - No smoking
     - Maintain clean atmosphere at home and at workplace
     - Regular breathing exercises
     - Antibiotics during episodes of infection
     - Bronchodilators orally (theophylline, doxofylline)
     - Bronchodilator inhalers (salbutamol, salmeterol)
     - Steroids orally or through inhaler
     - Nebulization with plain saline or bronchodilators
     - Chest physiotherapy
     - Good nutrition
     - Regulated intermittent oxygen (low-flow oxygen therapy to attain PaO_2 of 60–70 mmHg). Normally, CO_2 is the main respiratory drive but in advanced COPD, CO_2 is very high; and hypoxia becomes the main respiratory stimulant. Therefore, continuous O_2 administration blunts this hypoxic drive and the patient worsens.
     - Diuretics with CCF
     - Antitrypsin in deficient patients
     - Pneumococcal vaccine every 5–7 years and influenza vaccine every year
     - Pulmonary rehabilitation program
   - **b. Surgery**
     - Resection of nonfunctioning emphysematous areas

Viva voce

Q1. What are the clinical manifestations of CO_2 narcosis?

- Drowsiness progressing to coma
- Flapping tremors
- Bounding pulse
- Depressed deep tendon reflexes
- Retinal venous distension, papilledema

Q2. What are the causes of weight loss in emphysema?

- Increased work of breathing (increased BMR)
- Hypoxia
- Release of inflammatory cytokines (e.g. TNF-α)
- Reduced food intake

A case of bronchiectasis

Bronchiectasis is irreversible, localized dilatation and distortion of bronchi.

1. **Causes**
   - **a.** Bronchial obstruction (foreign body, thick secretions, tumor, external pressure by a mass or lymph nodes) resulting in localized lung collapse, which causes elastic traction on the bronchial wall in the affected lung segment. Secretions in the obstructed bronchus get infected, leading to destruction of bronchi.
   - **b.** In children, measles or whooping cough can be complicated by bronchopneumonia, which if inadequately treated can cause bronchiectasis.
   - **c.** Usually affects lower lobes (right > left) because right lower lobe bronchus is longer and narrower. Next common sites are middle lobe and lingula. **Brock's syndrome** is middle lobe bronchiectasis caused by pressure of lymph nodes in primary tuberculosis on the middle lobe

bronchus. Upper lobe bronchiectasis is uncommon. It is usually a sequela of apical tuberculosis.

2. **Predisposing factors**
   - **a.** Congenital structural defects
     - **i.** Tracheomegaly
     - **ii.** Pulmonary sequestration
   - **b.** Congenital disorders
     - **i.** Alpha-1 anti-trypsin deficiency
     - **ii.** Ciliary motility disorders, e.g. Kartagener's syndrome (situs inversus, agenesis of frontal sinuses, diminished ciliary motility, bilateral bronchiectasis)
     - **iii.** Fibrocystic disease (abnormal viscous secretions)
   - **c.** Primary immune deficiencies
     - **i.** Hypogammaglobulinemia (congenital or acquired)
     - **ii.** Chronic granulomatous disease
   - **d.** Acquired immune deficiency
     - **i.** HIV infection
     - **ii.** Steroids, immunosuppressive therapy
   - **e.** Infections (childhood measles, whooping cough, other bacterial infections including *Mycobacterium tuberculosis* and fungal infections)
   - **f.** Airway obstruction
     - **i.** Compression (tumor, lymph nodes)
     - **ii.** Intrinsic (foreign body, mucus plug, growth)
   - **g.** Toxic inhalations (chlorine, ammonia, nitric oxide)
   - **h.** Miscellaneous
     - **i.** Connective tissue diseases (e.g. rheumatoid arthritis)
     - **ii.** Inflammatory bowel disease (e.g. ulcerative colitis, Crohn's disease)
     - **iii.** Post lung transplantation
3. **Pathology**

   Types
     - **i.** Fusiform (narrowing at both ends)
     - **ii.** Cylindrical
     - **iii.** Saccular or cystic
4. **Clinical features**
   - **a.** **Symptoms** – Cough with large amount of yellowish sputum which often dates back to childhood/adolescence, foul-smelling sputum and recurrent (often massive) hemoptysis.
   - **b.** **Signs** – Patient looks sick and has foul-smelling breath and clubbing of finger/toe nails. Persistent medium/coarse localized crackles (often described as leathery) over lung bases (unilateral or bilateral) are heard. This is a characteristic finding. In a few cases, moist sounds are absent and patient may present only with recurrent hemoptysis (bronchiectasis sicca). Low-grade fever is present during exacerbations.
5. **Investigations**
   - **a.** Chest X-ray may be normal or show saccular or cystic dilatation of bronchi (Figs. 4.26 and 4.27).
   - **b.** Bronchography (Fig. 4.28), HRCT chest (Fig. 4.29). Both are diagnostic.

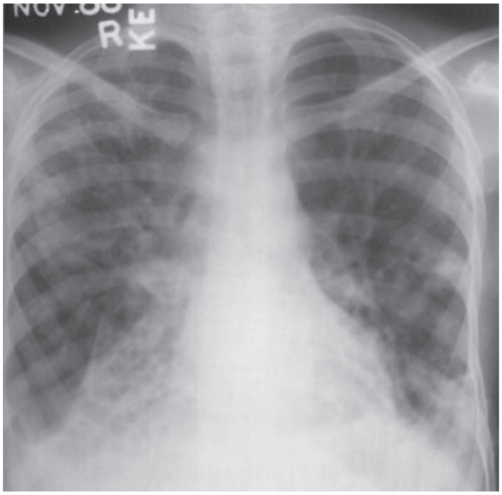


Figure 4.26 Bronchiectasis.

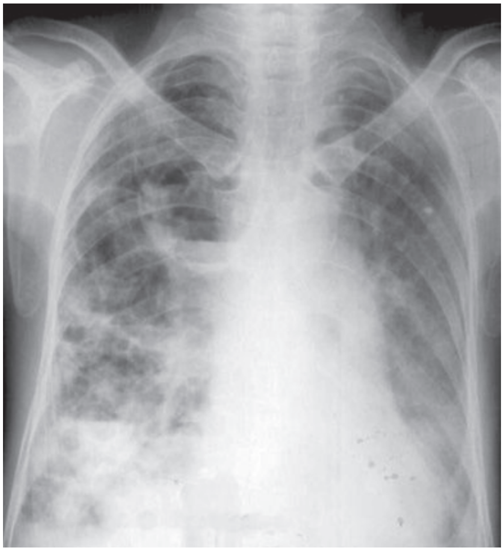


Figure 4.27 Cystic bronchiectasis.

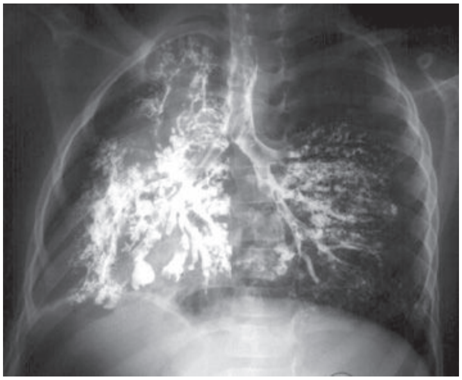


Figure 4.28 Bilateral basal bronchiectasis with bilateral upper lobe tuberculosis.

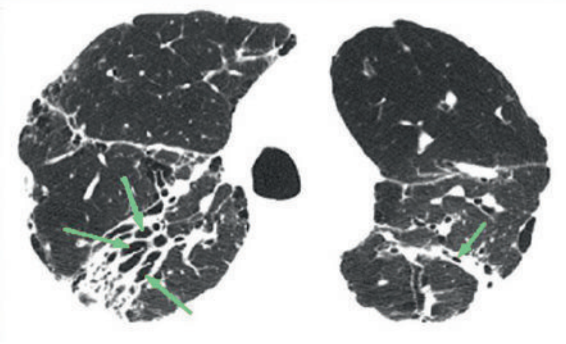


Figure 4.29 Computed tomography showing bronchiectasis.

- **c.** Sputum culture and sensitivity.
- **d.** Pulmonary function tests.
- **e.** Sweat chloride test (if cystic fibrosis is suspected).
- **f.** Serum immunoglobulin levels.
- **g.** Serum α-1 antitrypsin levels.
- **h.** Sperm motility (if ciliary dysfunction is suspected).

6. Complications

- **a.** Empyema
- **b.** Massive recurrent hemoptysis
- **c.** Lung abscess
- **d.** Recurrent pneumonia or chest infection
- **e.** Purulent pericarditis
- **f.** Metastatic brain abscesses
- **g.** Osteomyelitis
- **h.** Cor pulmonale with or without CCF
- **i.** Secondary amyloidosis

7. Management

- **a. Medical**
  - **i.** Antibiotics as indicated (based on culture sensitivity)
  - **ii.** Postural drainage, chest physiotherapy
  - **iii.** Mucolytics, expectorants and bronchodilators
  - **iv.** Steam inhalations
  - **v.** No cigarette smoking. Avoid sedatives and antitussive drugs.
- **b. Surgical**
  - **i.** Bronchoscopy and removal of foreign body for obstructive cause
  - **ii.** Resection of affected lobe/segment; considered only if medical treatment fails and disease is localized.
  - **iii.** Bronchial artery embolization for massive hemorrhage

A case of lung abscess

Definition – Lung abscess is a necrotizing infection localized to a part of the lung with pus formation.

1. Etiology

- **a.** Lung diseases –
  - Suppurative pneumonia
  - Bronchiectasis
  - Foreign body causing collapse with supervening infection
  - Secondary infection of bronchogenic cyst
  - Hydatid cyst or bronchogenic carcinoma.
- **b.** Aspiration – Aspiration of vomitus or food material in an unconscious person (postoperative, after sedation, alcohol, epileptic fit, cerebrovascular accident, head injury, pseudobulbar palsy). Following aspiration in supine position, posterior segments of upper lobes and apical segments of lower lobes of either lung are involved. Usually abscesses are multiple.
- **c.** Hematogenous spread from abdominal/pelvic sepsis, I/V drug abuse (right side endocarditis).
- **d.** Both anaerobic and aerobic organisms are causative agents. Most common organisms are streptococci. In immunocompromised patients, nocardia, *M. tuberculosis*, fungi and protozoa can cause lung abscess.

2. Clinical features – Symptoms due to aerobic bacterial infection develop rapidly, whereas in the case of anaerobic bacteria, the illness is chronic.

- **a. Symptoms** – Fever with chills and sweating, cough with purulent expectoration,

breathlessness, loss of appetite and weight. Hemoptysis may be present.
  - **b. Signs** – Patient is febrile, looks toxic and dyspneic. There is halitosis. Clubbing and pallor are present in chronic abscess. Signs of cavity with secretions are present if the abscess is superficial. With deep-seated small cavity and with thick wall, only dull note and diminished breath sounds are present.

3. Investigations
  - **a.** Blood – Leukocytosis, anemia, elevated ESR.
  - **b.** Chest X-ray – Posteroanterior view (Figs. 4.30 and 4.31). For detail see chapter on Imaging

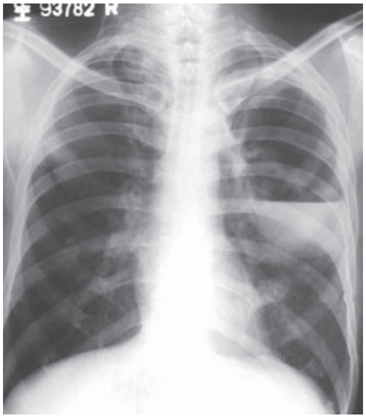


Figure 4.30 Left midzone lung abscess.

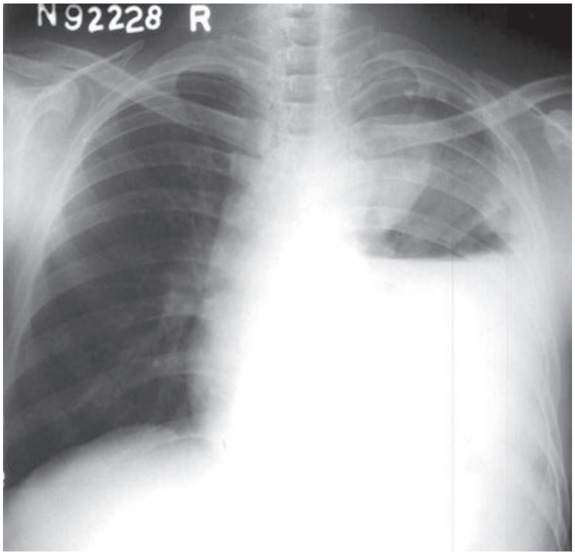


Figure 4.31 Lung abscess with left pleural effusion.

  - **c.** Computed tomography scan to differentiate between lung abscess and loculated empyema.
  - **d.** Sputum smear examination and culture/sensitivity test.
  - **e.** Bronchoscopy to rule out foreign body, tumor (particularly bronchogenic carcinoma).

4. Differential diagnosis – Mainly from tuberculous lung abscess (Table 4.5).

5. Complications
  - **a.** Empyema, bronchopleural fistula with pyopneumothorax, purulent pericarditis
  - **b.** Metastatic abscesses
  - **c.** Severe hemoptysis
  - **d.** Secondary amyloidosis (with chronic abscess)

Table 4.5 Differences between tuberculous cavity and pyogenic lung cavity

	Tuberculous lung abscess	Pyogenic lung abscess
Fever	Low grade	High grade with rigors
Appearance	Weight loss	Toxic
Sputum	Usually blood stained	Large amount, foul-smelling
Clubbing	Usually absent	Present with disease of >6-week duration
Chest X-ray (fluid level)	Absent (Fig. 4.33)	Present (Figs. 4.30 and 4.31)
Wall	Thick or thin	Thick
Microscopy	AFB +ve	Gram +ve and Gram −ve organisms

6. Treatment
  - **a. Medical**
    - **i.** Antibiotics as per sensitivity
    - **ii.** Physiotherapy plus postural drainage – To be avoided in acute, early abscess.
    - **iii.** Steam inhalations.
    - **iv.** Aspiration of pus by fiberoptic bronchoscopy or percutaneously in non-responders.
    - **v.** If empyema is present, drainage.
  - **b. Surgical**
    - **i.** Resection of segment/lobe if medical treatment fails.

Viva voce

Q1. What are the causes of collapse consolidation?

Collapse consolidation is due to endobronchial obstruction by tumor, stricture, foreign body and thick viscid secretions.

Q2. What are the sites of aspiration pneumonia?

- Posterior segment of upper lobe
- Apical segment of lower lobe (right > left)
- Middle lobe and lingula (following drowning or vomiting)

Q3. Enumerate lung diseases with jaundice

- Associated liver disease (cirrhosis)
- Lung malignancy with liver metastasis
- Pulmonary infarction
- Legionella, mycoplasma pneumonias
- Rarely pneumococcal pneumonia

A case of pulmonary tuberculosis

Tuberculosis is a systemic disease, which involves practically all organs and tissues of the body. Pulmonary tuberculosis is the commonest manifestation. Tuberculosis is caused by *M. tuberculosis*. The route of entry is inhalation or ingestion. Transmission is by droplet infection from an infected patient.

Primary pulmonary tuberculosis

This commonly affects lungs though in a few it may start in gastrointestinal tract or tonsils. The infection occurs in infants and young children. The primary focus (Ghon's focus) is subpleural, usually in the lower part of upper lobe. Local lymph glands (hilar) get enlarged. This combination of Ghon's focus and enlarged lymph nodes is called *primary complex*. In majority of cases, the primary complex heals, leaving behind a healed scar, which on chest X-ray appears as a calcified lesion. However, in persons who suffer from malnutrition or uncontrolled diabetes mellitus and who are immunocompromised (HIV positive), the Ghon's focus may rupture in the pleural cavity causing acute pleurisy with effusion or may spread in the lung. Hilar lymph nodes may enlarge and cause compression of bronchus resulting in collapse consolidation or lesion may rupture into bronchus causing endobronchial tuberculosis or rupture into pulmonary vessels causing hematogenous spread resulting in miliary tuberculosis, including tuberculous meningitis.

Patients with primary tuberculosis may have fever, loss of appetite, loss of weight, cough, harsh vesicular breathing and few adventitious sounds. Some patients may present with hypersensitivity reactions such as phylectenular conjunctivitis or erythema nodosum (see Figs. 9.14a and 9.14b).

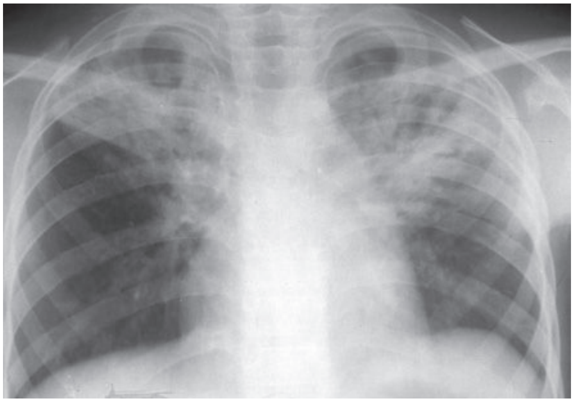


Figure 4.32 Adult-type tuberculosis in a child.

In a few cases, primary focus may progress actively to manifest as post primary tuberculosis in children (Fig. 4.32), whereas in the majority, it remains silent and may get reactivated when patient's resistance is low.

Postprimary tuberculosis

Upper lobe (posterior segment) and apical segment of lower lobe are the common sites of post primary tuberculosis because in the upright position, there is decreased blood flow and better ventilation in these areas.

Patient presents with low-grade fever and cough with expectoration. Physical signs depend upon whether patient has pulmonary infiltration, consolidation, cavity, fibrosis or fibrocaseous tuberculosis. Bronchovesicular or bronchial breathing with increased VR and fine to medium crackles may be present. One should differentiate tuberculosis cavity (Fig. 4.33) from lung abscess cavity (Fig. 4.30; Table 4.5). Some patients may develop pleural effusion or hydropneumothorax. Hemoptysis may occur in some due to rupture of blood vessels.

Immunocompromised patients may present as miliary tuberculosis due to hematogenous spread causing nodular shadows in lungs, hepatosplenomegaly, tuberculous meningitis and choroid tubercles. In miliary tuberculosis of lungs, physical signs are scanty but chest X-ray is diagnostic (Fig. 4.34). Patients with hematogenous spread may have associated genitourinary tuberculosis,

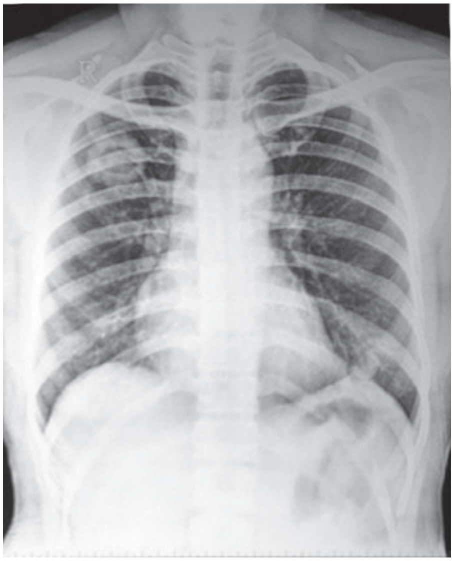


Figure 4.33 Thick-walled cavity in right upper zone – tuberculosis.

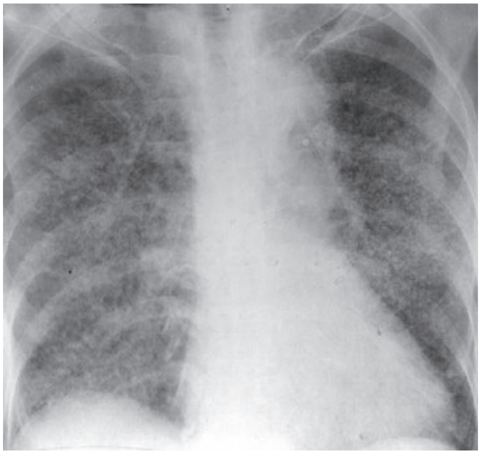


Figure 4.34 Miliary tuberculosis.

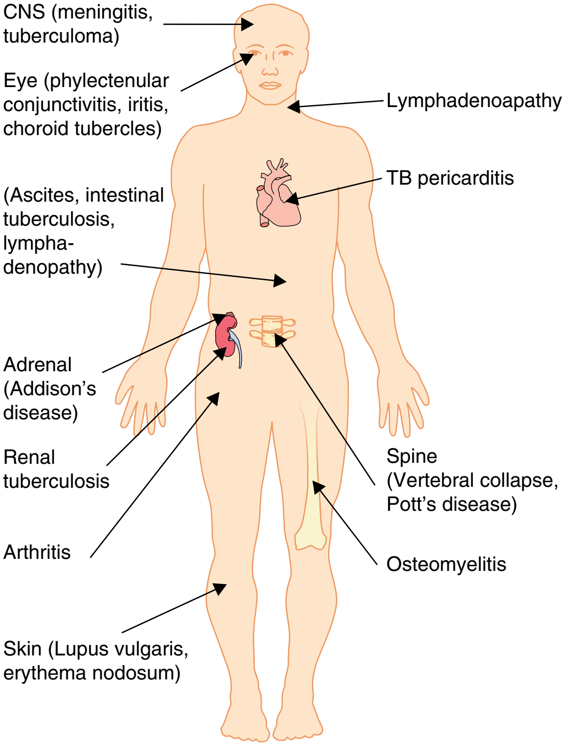

CNS (meningitis, tuberculoma)
Eye (phylectenular conjunctivitis, iritis, choroid tubercles)
Lymphadenoapathy
TB pericarditis
(Ascites, intestinal tuberculosis, lymphadenopathy)
Adrenal (Addison's disease)
Renal tuberculosis
Arthritis
Spine (Vertebral collapse, Pott's disease)
Osteomyelitis
Skin (Lupus vulgaris, erythema nodosum)

Figure 4.35 Sites of extrapulmonary tuberculosis.

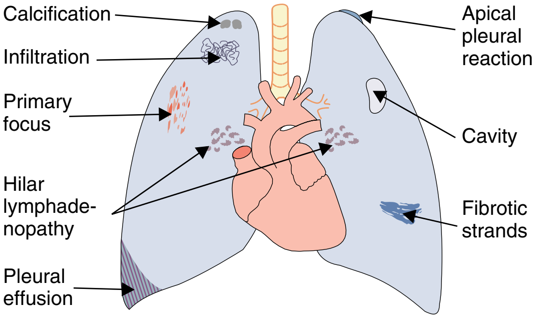

Calcification
Infiltration
Primary focus
Hilar lymphadenopathy
Pleural effusion
Apical pleural reaction
Cavity
Fibrotic strands

Figure 4.36 X-ray features of pulmonary tuberculosis.

tuberculosis of spine (Pott's disease), tuberculosis of a large joint (e.g. hip joint) or tuberculosis of abdomen (see Fig. 4.35 for sites of extrapulmonary tuberculosis).

1. **Investigations**
   - **a.** Complete blood count reveals normal WBC count with lymphocytic predominance, and low Hb.
   - **b.** Erythrocyte sedimentation rate is elevated (may be >100 mm/hr).
   - **c.** Sputum for AFB on three consecutive days.
   - **d.** Sputum for AFB culture and sensitivity.
   - **e.** Tuberculin (Mantoux) test or TB gold test. (Both of limited value for diagnosis of tuberculosis.)
   - **f.** Polymerase chain reaction (PCR) for tuberculosis (sputum, pleural fluid, blood, CSF).
   - **g.** Chest X-ray (Fig. 4.36 shows X-ray features of pulmonary tuberculosis; Fig. 4.37 reveals chest X-ray showing bilateral pulmonary tuberculosis).
   - **h.** Computed tomography chest.
   - **i.** Diagnostic pleural aspiration.

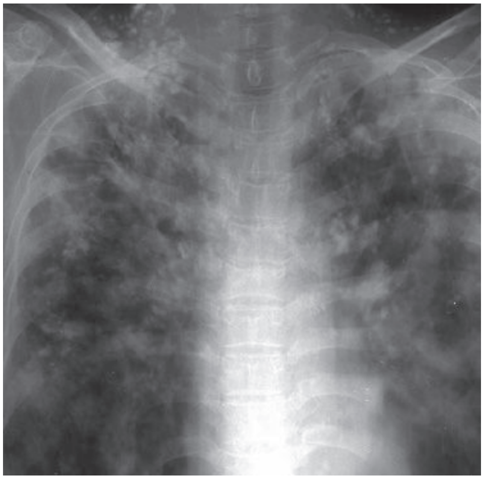


Figure 4.37 Bilateral pulmonary tuberculosis.

2. **Management**
   - a. **First-line drugs**
     Streptomycin, rifampicin, isoniazid, pyrazinamide, ethambutol
   - b. **Second-line drugs**
     Cycloserine, para-aminosalicylic acid (PAS), ethionamide, ciprofloxacin, levafloxacin, thiacetazone, kanamycin, capreomycin, amikacin, moxifloxacin, gatifloxacin

Majority of patients can be managed with 6-month regimen, starting with four drugs (rifampicin, isoniazid, pyrazinamide and ethambutol) for 2 months, followed by three drugs (rifampicin, isoniazid, ethambutol) for 4 months.

Monitor liver function tests as these drugs are hepatotoxic. For prevention of B6 (pyridoxine) deficiency seen with isoniazid, vitamin B6 (40 mg daily) is administered as a routine.

DOTS: Directly observed treatment is advised particularly in rural areas. Short-course chemotherapy for 6 months suffices.

Corticosteroids are useful in the management of tuberculous meningitis, miliary tuberculosis, in some cases of pleural effusion, in severe toxemia due to fulminant hematogenous tuberculosis and Addison's disease.

Viva Voce

Q1. What are bactericidal and bacteriostatic anti tuberulosis drugs?

Bactericidal drugs (streptomycin, rifampicin, isonaizid, pyrazinamide) Bacteriostatic drugs (ethambutol, PAS, thiacetazone, ethionamide)

A case of sarcoidosis

1. **Introduction** – Sarcoidosis is a noncaseating granulomatous disease involving one or more organs and tissues. Lungs and lymphatic system are the most common sites of involvement. Granulomas in the lung are most commonly present in the peribronchiolar and subpleural regions.
   - a. Prevalence – Sarcoidosis is more common in the west and Japan, and in blacks than in whites in United States (10:1 ratio).
   - b. Etiology – Unknown. Sarcoid granuloma, which is noncaseating, occurs as a specific immunologic response to some antigens in individuals with genetic predisposition.
   - c. Cell-mediated immunity (CMI) is depressed; hence CMI test like tuberculin reaction is subnormal.
2. **Clinical features** – Refer Fig. 4.38 for clinical features, Fig. 4.39 for skin plaques and Fig. 4.40 for uveitis

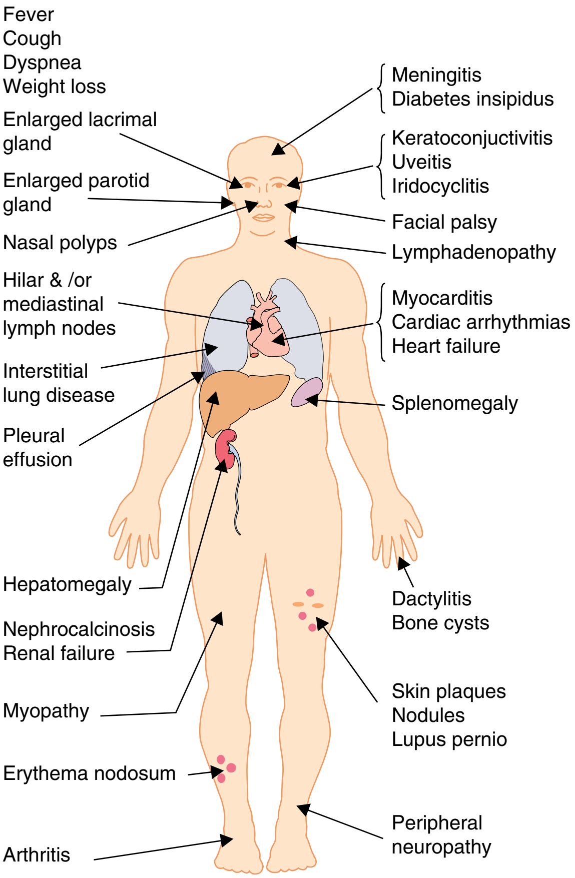

Fever
Cough
Dyspnea
Weight loss
Enlarged lacrimal gland
Enlarged parotid gland
Nasal polyps
Hilar & /or mediastinal lymph nodes
Interstitial lung disease
Pleural effusion
Hepatomegaly
Nephrocalcinosis
Renal failure
Myopathy
Erythema nodosum
Arthritis
Meningitis
Diabetes insipidus
Keratoconjuctivitis
Uveitis
Iridocyclitis
Facial palsy
Lymphadenopathy
Myocarditis
Cardiac arrhythmias
Heart failure
Splenomegaly
Dactylitis
Bone cysts
Skin plaques
Nodules
Lupus pernio
Peripheral neuropathy

Figure 4.38 Clinical features of sarcoidosis.

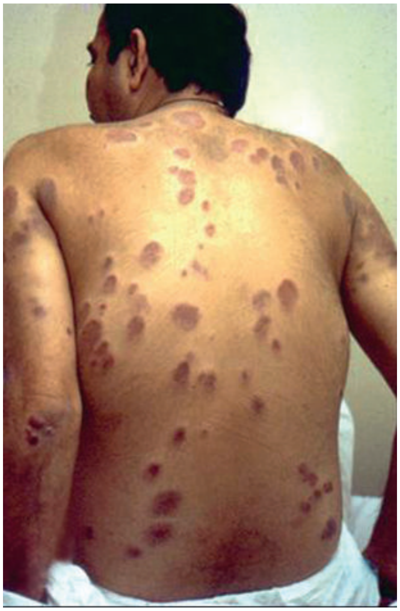


Figure 4.39 Skin plaques and nodules.

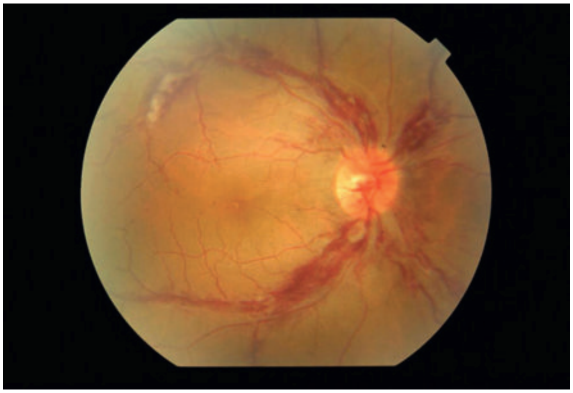


Figure 4.40 Posterior uveitis in sarcoidosis.

3. **Investigations**
   - **a.** Blood – Normal total WBC count, lymphopenia; elevated ESR, serum calcium, globulins and uric acid. There is reversal of albumin:globulin ratio (30% cases).
   - **b.** Tuberculin test – Negative (in 60%), Kveim–Siltzbach test – Intradermal injection of sarcoid antigen results in typical local granulomatous reaction (98% positive), but is not done these days.
   - **c.** Serum angiotensin converting enzyme (SACE) – It is raised in 70% but is more useful in monitoring response to therapy than for the diagnosis as it is not specific for sarcoidosis.
   - **d.** Pulmonary function tests – Typically show restrictive pattern with decreased DLCO. In later stages, obstructive pattern supervenes (mixed restrictive plus obstructive pattern).
   - **e.** Biopsy – Biopsy of involved tissues shows noncaseating granuloma.
   - **f.** Radiological staging
     - **i.** Stage I – Hilar and mediastinal lymphadenopathy without lung disease.
     - **ii.** Stage II – Stage I plus parenchymal lung disease (interstitial infiltrates) (Fig. 4.41).
     - **iii.** Stage III – Parenchymal disease (ILD) without hilar lymph node enlargement.
     - **iv.** Stage IV – Diffuse fibrosis, conglomerate masses, traction bronchiectasis, and cysts

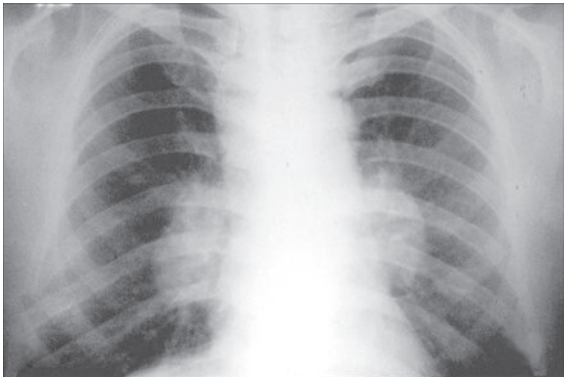


Figure 4.41 Sarcoidosis – Chest X-ray showing hilar lymphadenopathy with interstitial infiltrates.

These stages are not mutually exclusive.

Note – HRCT is more sensitive than chest X-ray both for diagnosis and staging.

4. **Management**
   - **a.** Symptomatic treatment in the majority.
   - **b.** Corticosteroids starting with 60 mg prednisone tapering slowly to daily maintenance dose of 10–15 mg, which is continued for 1–2 years for patients with lung involvement or extrathoracic disease.
   - **c.** Additionally immunosuppressive drugs; most commonly methotrexate; chloroquine or hydroxychloroquine are also used in some cases.

A case of bronchogenic carcinoma Most common cancer in men

1. **Etiopathology**
   Etiological factors –
   - a. Smoking is an important risk factor. Cigarette and bidi smoking are equally harmful. Pipe, cigars and hookah smoking carries less risk.
   - b. Exposure to ionizing radiation, iron oxides, beryllium, arsenic, asbestos, petrochemicals.
   - c. Chronic obstructive pulmonary disease and pulmonary fibrosis increase susceptibility.
   - d. Genetic factors.
2. **Histopathological types of carcinoma lung (WHO classification)**
   - a. Squamous cell carcinoma
   - b. Oat cell carcinoma
   - c. Adenocarcinoma
   - d. Large- (giant-) cell carcinoma
   - e. Adenosquamous carcinoma
3. **Clinical features**
   - a. Asymptomatic in up to 25%
   - b. Symptoms
     - i. Local effects – Cough, hemoptysis and chest discomfort.
     - ii. Regional spread – Mediastinal compression syndrome, pleuritic chest pain, pleural effusion, Pancoast tumor.
     - iii. Metastasis – Liver, brain and bones.
   - c. Nonmetastatic manifestations (paraneoplastic manifestations)
     - i. Fever, loss of appetite and weight, anemia.
     - ii. Neurologic – Peripheral neuropathy, cerebellar syndrome, dementia.
     - iii. Endocrine – Syndrome of inappropriate antidiuretic hormone secretion, Cushing's syndrome, carcinoid syndrome, gynecomastia, hypercalcemia, somatostatinoma.
     - iv. Bones and joints – Hypertrophic osteoarthropathy (Fig. 4.42).
     - v. Neuromuscular – Peripheral neuropathy, polymyositis, dermatomyositis, cerebellar degeneration, spinocerebellar degeneration, Eaton–Lambert syndrome.
     - vi. Cardiovascular – Nonbacterial endocarditis (merantic), migratory thrombophlebitis.
     - vii. Hematologic – disseminated intravascular clotting.
   - d. Signs
     - i. Depend upon stage and size of the growth. In early cases signs may be absent
     - ii. Patient looks sick, emaciated with clubbing, pulmonary osteoarthropathy and lymph node enlargement (supraclavicular glands).
     - iii. Trachea may be shifted to the side of tumor because of collapse of the segment/lobule due to bronchial obstruction. Unilateral wheeze is a rare but a characteristic finding. Pleural effusion may be present if pleura is involved.
4. **Investigations**
   - a. Chest X-ray may show a single mass, solitary nodule or multiple masses (Fig. 4.43),

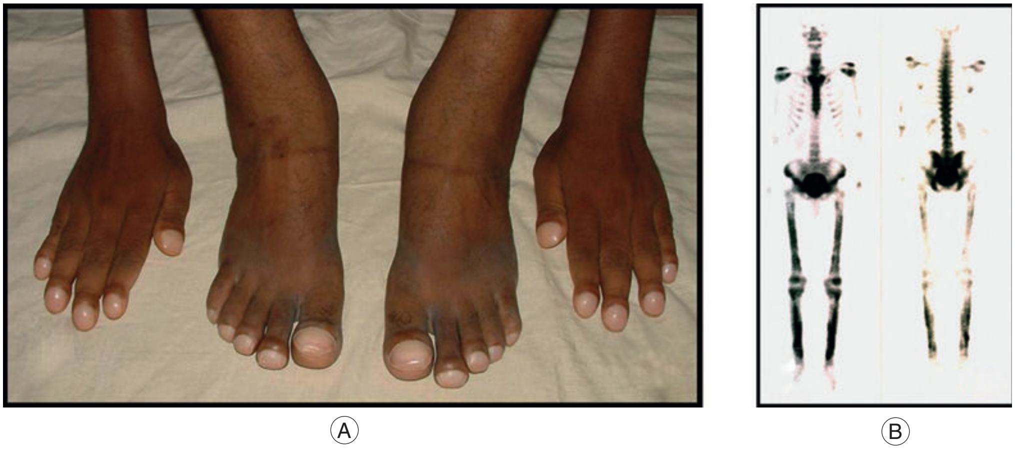


Figure 4.42 Pulmonary hypertrophic osteoarthropathy. (A) Clubbing of the digits with widening at the wrists and ankles. (B) Bone scan showing increased radionuclide uptake.

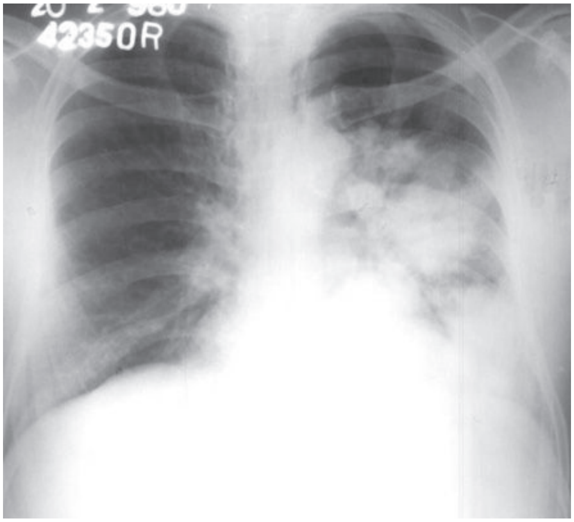


Figure 4.43 Squamous carcinoma with metastasis.

mediastinal widening, collapse, infiltrates, cavitary lesion, pleural effusion, but none are diagnostic. Differential diagnosis includes pneumonia, pulmonary tuberculosis, benign tumors and lung abscess.

- **b.** Computed tomography scan of chest.
- **c.** Magnetic resonance imaging for apical tumors.
- **d.** Bronchoscopy
- **e.** Biopsy essential for diagnosis. It can be
  - ❑ Transbronchial
  - ❑ Computed tomography guided
  - ❑ Aspiration of peripheral tumor (ultrasound-guided)
  - ❑ Mediastinoscopic
  - ❑ Transthoracic lung biopsy.
- **f.** Cytology of bronchopulmonary secretions and pleural fluid.

5. **Prognosis** – Varies with size, type and grade of tumor. It is generally poor.
6. **Management**
   - **a.** Non–small cell carcinoma – Treatment is stage dependent.
     - **i.** Surgical resection – Treatment of choice for Stages I and II;
     - **ii.** Chemotherapy with radiation therapy for stages III and IV.
     - **iii.** Biological agents – Biological agents that inhibit epidermal growth factors are being developed and tested.
     - **iv.** Radiation therapy – It is used for palliative purposes.
     - **v.** Chemotherapy – It is used as an induction (neoadjuvant) therapy in locally advanced surgically resectable disease.
   - **b.** Small-cell carcinoma – It is usually not amenable to surgery, responds to chemotherapy and radiation therapy but the effect is short lived.

A case of collapse of lung

1. **Types of collapse**
   - **a.** Relaxation collapse (secondary to pleural effusion, pneumothorax).
   - **b.** Compression collapse (massive pleural effusion, tension pneumothorax, large tumor).
   - **c.** Absorption collapse due to bronchial obstruction.
     - **i.** Endobronchial obstruction (foreign body, tumor, thick mucus secretions or mucus plug bronchial stricture)
     - **ii.** Extrinsic compression of bronchus (tumors, enlarged lymph nodes, aneurysm of aorta).

   Note – The term collapse when unqualified means absorption collapse
2. **Clinical presentation**
   - **a.** Atelectasis causes outward pull on the bronchi, which along with infection results in bronchiectasis.
   - **b.** Symptoms vary according to the onset (sudden or insidious), severity and extent of collapse. Cough and dyspnea are common symptoms.
   - **c.** Retraction of the chest wall on the side of collapse with trachea and mediastinum pulled to the affected side
   - **d.** Diminished or absent chest movements, diminished or absent vocal fremitus
   - **e.** Dull percussion note
   - **f.** Absent breath sounds
   - **g.** Absent vocal resonance
   - **h.** If bronchial communication is reestablished, but the lung remains collapsed bronchial breath sounds with increased VR, WP and crackles are heard during auscultation; repeated infections may result in pneumonic consolidation (collapse consolidation), when bronchial breathing with increased VR and WP along with crackles is present
3. **Investigations**
   - **a.** Chest X-ray (posteroanterior and lateral views) to confirm the diagnosis.

   - **b.** Computed tomography scan for more details of lung involvement.
   - **c.** Bronchoscopy to identify the cause of obstruction and treat if possible (e.g. foreign body removal).
4. **Principles of management**
   - **a.** Collapse due to foreign body or mucus plug obstructing a bronchus is a medical emergency and needs immediate bronchoscopic removal.
   - **b.** Other measures according to the underlying cause.

A case of pulmonary fibrosis

1. **Etiology** – It is a sequelae of several lung diseases.
   - **a.** Post infective (tuberculous, bacterial, fungal, parasitic)
   - **b.** Post radiation
   - **c.** Connective tissue disorders (RA, systemic lupus erythematosus, systemic sclerosis)
   - **d.** Occupational lung diseases (silicosis, asbestosis, anthracosis, berylliosis, siderosis). The clinical signs depend upon the cause and type.
   - **e.** Sarcoidosis
   - **f.** Idiopathic lung disease (ILD).
2. **Clinical presentation**
   - **a. Symptoms** – Dyspnea and cough are common symptoms. Cyanosis is present in advanced cases.
   - **b. Signs** – In localized type, there is retraction of chest; shift of mediastinum with unilateral disease corresponding to the affected area; diminished chest movements and impaired percussion note; diminished air entry with diminished VF and VR; crackles and rhonchi over the area. In diffuse ILD, there is diminished chest expansion, with typical Velcro crackles. Mild clubbing is usually present.
3. **Investigations**
   - **a.** Chest X-ray is often diagnostic of ILD (Fig. 4.44); HRCT chest is more sensitive and shows ground glass appearance (Fig. 4.45), septal thickening and traction bronchiectasis.
   - **b.** Pulmonary function tests show restrictive pattern with decreased DLCO.
4. **Principles of management**
   - **a.** Symptomatic treatment
   - **b.** Treatment of underlying cause

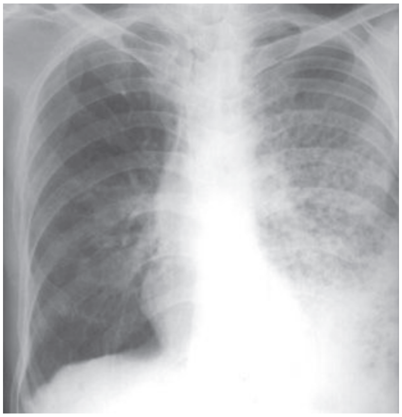


Figure 4.44 Interstitial lung disease.

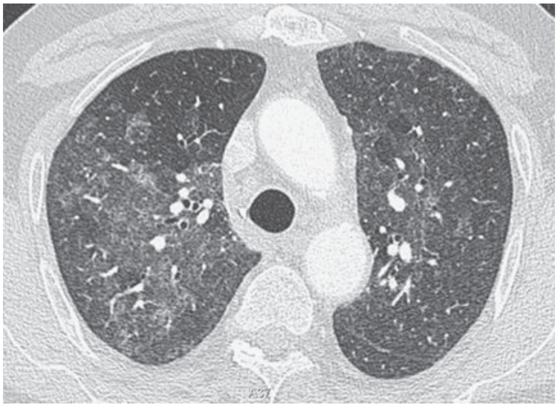


Figure 4.45 Computed tomography showing ground glass appearance in ILD.

   - **c.** Breathing exercises
   - **d.** Oxygen administration in advanced cases

A case of pleurisy

Dry fibrinous pleurisy

Inflammation of pleura occurs invariably due to an underlying lung disease (e.g. pneumonia, pulmonary infarction, tuberculosis, bronchiectasis) or as a feature of systemic disease (e.g. RA, systemic lupus erythematosus, uremia).

Pleurisy with effusion

Pleurisy with effusion is a collection of fluid in the pleural cavity (space). It can be an exudate, transudate, hemothorax, (blood), chylothorax, chyliform or purulent (empyema).

1. **Etiology**
   - **a.** Infection (Mycobacterium tuberculosis, pyogenic organisms, viruses, fungi and parasites)

- **b.** Malignancy
    - **i.** Primary (with ovarian cancer without metastasis – Meigs' syndrome)
    - **ii.** Pleural secondaries (lung and breast most common primary sites)
    - **iii.** Mesothelioma.
- **c.** Rheumatic disorders (RA, systemic lupus erythematosus, Still's disease)
- **d.** Drugs (hydralazine, procainamide, nitrofurantoin, bromocriptine, methysergide)
- **e.** Spread from contiguous pathologies
    - **i.** Amebic liver abscess, subphrenic abscess
    - **ii.** Esophageal rupture
    - **iii.** Pancreatitis
- **f.** Asbestosis
- **g.** Others (pulmonary infarction, uremia, post coronary artery bypass graft)

2. Clinical presentation – Tuberculosis is commonest cause of pleural effusion in India

- **a.** Fever with pleuritic chest pain worsened by breathing or coughing.
- **b.** Large effusions cause breathlessness
- **c.** Over the effusion, fullness of ICSs with tense effusion diminished movements and diminished TVF, trachea shifted to opposite side, stony dull percussion note, absent breath sounds, diminished VR. Egophony above the level of fluid may be present. Trachea shifted to same side in case of endobronchial growth causing absorption collapse. Pleural rub may be heard in the early stage and in the resolving stage. Pleural rub in acute pleuritic stage is accompanied by pain on breathing, whereas pleural rub is painless in the resolving stage.

3. Investigations

- **a.** Complete blood count, ESR, sputum for AFB, malignant cells, Mantoux test, TB gold test
- **b.** Antinuclear antibody, RA test.
- **c.** Chest X-ray
    - **i.** Posteroanterior view (minimum 300 ml of fluid must be present for radiological detection) (Fig. 4.46). Lateral view is indicated for encysted interlobar and infrapulmonary effusions.
    - **ii.** Small pleural effusion is better visualized in lateral decubitus view Fig. 4.47).

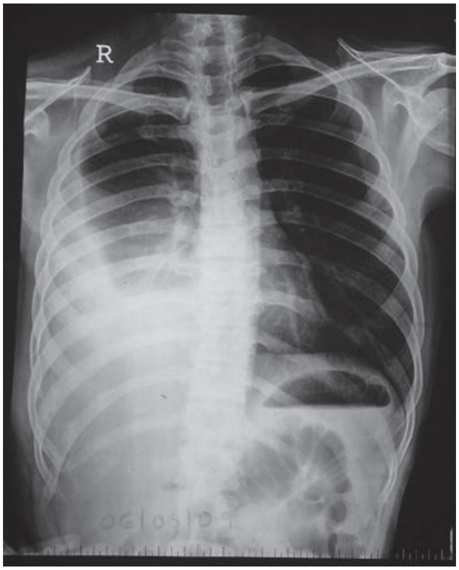
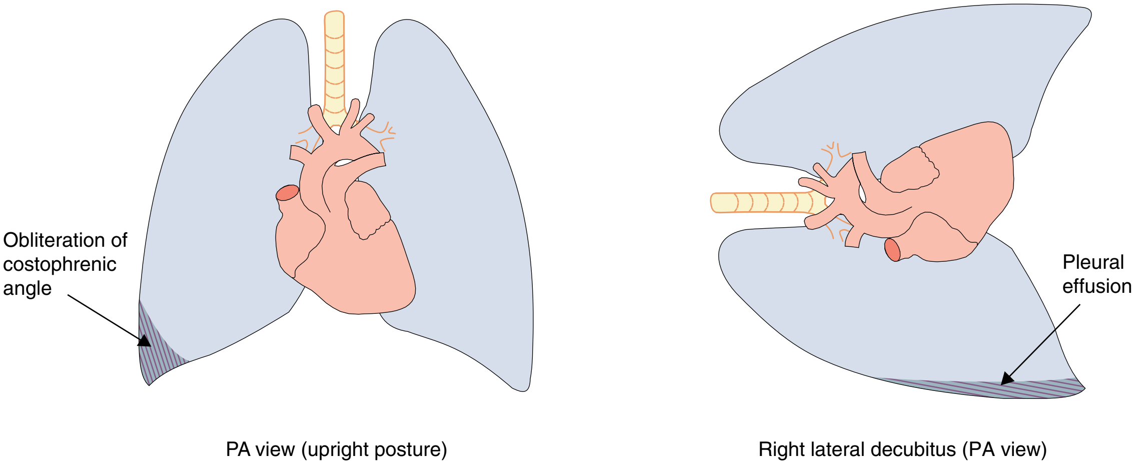


Figure 4.46 Pleural effusion (moderate) right side.



PA view (upright posture)

Right lateral decubitus (PA view)

Figure 4.47 Small pleural effusion is better visualized in lateral decubitus view.

Table 4.6 Differential features of exudate and transudate

	Exudate	Transudate
Naked eye appearance	Straw-colored, cloudy, purulent, blood stained	Clear or light yellow
Proteins	>3.0 g/100 ml	<3.0 g/100 ml
Lactate dehydrogenase	High (>200 U/l)	Low (<200 U/l)
Pleural fluid protein:serum protein ratio	>0.5	<0.5
Pleural fluid lactate dehydrogenase: serum lactate dehydrogenase ratio	>0.6	<0.6
WBC	>1000/mm^3 (lymphocytic in tuberculosis), polymorphonuclear in bacterial infection	<1000/mm^3
Glucose	Low in infections, very low in RA	Same as blood glucose

- **iii.** In basal pleural effusion (infrapulmonary effusion), which mimics elevated hemidiaphragm, lateral decubitus view is necessary to differentiate the two.

d. Computed tomography scan to diagnose underlying cause (parenchymal pathology, mediastinal and hilar lymph nodes).
e. Bronchoscopy along with biopsy (if indicated).
f. Diagnostic pleural aspiration, ultrasound-guided for small effusions (Table 4.6).

Special pleural fluid studies

1. Elevated adenosine deaminase level (greater than 40 units) suggests tuberculosis.
2. Presence of mycobacterial DNA detected by PCR.
3. Elevated serum amylase in acute pancreatitis, esophageal rupture, chronic pancreatico-pleural fistula.
4. Cytology for malignant cells; more than 5% mesothelial cells exclude tuberculosis.
5. Measurement of SACE levels to differentiate tuberculosis from sarcoidosis, SACE is elevated in sarcoidosis.
6. Pleural biopsy – (see Chapter 12)
7. Other investigations – CBC/ESR, sputum for AFB and malignant cells, Mantoux test, ANA, rheumatoid factor.

Differential diagnosis (see Table 4.7)

Table 4.7 Major differences between pleural effusion and consolidation

Features	Pleural effusion	Consolidation
Trachea and heart	Shifted to opposite side	Central
Percussion note	Stony dull	Impaired
Traube's space	Obliterated in left-side effusion	Preserved
Intercostal fullness	May be present with massive effusion	Not present
Intercostal tenderness	Present with empyema	None
Breath sounds	Absent	Tubular bronchial breathing
Pleural rub	May be present	Absent
Vocal resonance	Decreased or absent	Increased
Egophony	Present above effusion	Absent; WP present

Viva voce

Q1. What are the causes of hemothorax? (In hemothorax, pleural fluid hematocrit [HCT] is greater than 50% of peripheral HCT.)

- Malignancy
- Trauma
- Coagulation disorders
- Rupture of aortic aneurysm or pulmonary artery
- Tuberculosis

Q2. What are the causes of chylothorax?

- Trauma to thoracic duct
- Neoplasm involving thoracic duct, most commonly lymphoma
- Filariasis

Q3. What is chyliform effusion?

Chyliform or pseudochylous effusion. It occurs in long standing effusion with thickened pleura. It is due to high cholesterol with low triglycerides resulting from impaired absorption of cholesterol due to thickened pleura seen in some chronic cases of tuberculosis and rheumatoid arthritis.

A case of empyema

1. **Etiology**
   - **a. Spread from adjacent structures**
     - **i.** Lung (pneumonia, bronchiectasis, lung abscess, tuberculosis)
     - **ii.** Subphrenic abscess
     - **iii.** Liver abscess
     - **iv.** Osteomyelitis of rib, vertebra
   - **b. Traumatic**
     - **i.** Penetrating chest injury
     - **ii.** Cardiothoracic surgery, intercostal drainage
     - **iii.** Complication of pleural aspiration
2. **Causative organisms**
   - **a.** Bacteria (Gram +ve, and Gram –ve)
   - **b.** *M. tuberculosis*
   - **c.** Fungi
   - **d.** Protozoa (*Entamoeba histolytica*) – rupture of amebic liver abscess
3. **Clinical features**
   - **a. Symptoms** – Fever with chills and rigors, chest pain, dyspnea and cough. Purulent sputum if bronchopleural fistula is present.
   - **b. Signs** – Signs of pleural effusion plus tenderness over ICSs. Rarely empyema necessitans (empyema tracking into subcutaneous tissues of chest wall) may be present. It is mostly seen in actinomycotic infection. There is localized bulge and a positive cough impulse. In chronic cases, pleural thickening with loculation of pus may result in chest retraction.
4. **Diagnosis**
   - **a.** Pleural fluid is turbid or frank pus. Ultrasound-guided aspiration is desirable.
5. **Complications**
   - **a.** Pleural thickening with fibrosis and sometimes calcification.
   - **b.** Bronchiectatic changes in underlying lung.
   - **c.** In tuberculous infection, sometimes discharging sinus and secondary amyloidosis.
6. **Principles of management**
   - **a.** Antibiotics (initially empirical, later according to culture sensitivity report)
   - **b.** Closed or open drainage of empyema
   - **c.** Decortication in the presence of pleural fibrosis

Viva voce

Q1. What clinical signs you would look for above the level of pleural effusion?

One may get hyperresonant boxy percussion note (skodaic resonance) above the level of pleural effusion, bronchial (tubular) breath sounds with increased VR (bronchophony) and even WP. In some cases VR may resemble egophony.

Q2. What are the causes of bilateral pleural effusion?

- Congestive cardiac failure
- Cirrhosis of liver
- Nephrotic syndrome
- Hypoproteinemia
- Meigs' syndrome
- Myxedema
- Systemic lupus erythematosus
- Secondaries
- Pancreatitis

Q3. What are the causes of hemorrhagic pleural effusion?

- Malignancy
- Tuberculosis
- Pulmonary infarction

Q4. What are the causes of pleural thickening?

- Tuberculosis
- Empyema
- Hemothorax

Q5. What is Bornholm disease?

It is fibrinous pleurisy caused by Coxsackie B virus infection. It presents with sudden onset of severe chest pain, local tenderness and restricted thoracic movements. Usually occurs in epidemic form and affects young persons. It is a self-limited condition, lasts for few days. Treatment is symptomatic. Recurrence may occur over few weeks. Aseptic meningitis, orchitis or fibrinous pericarditis and pleurisy may develop in a small percentage of patients. Diagnosis is confirmed by rising neutralizing antibody titers or throat and stool culture.

A case of pneumothorax

Pneumothorax – It is air in pleural cavity. Its causes are

- Primary spontaneous (without underlying lung pathology)
- Secondary spontaneous (with underlying pulmonary pathology such as emphysematous bullae or subpleural apical tuberculosis)
- Traumatic

Types of pneumothorax (Fig. 4.48)

1. **Closed pneumothorax** – Here, the site of rupture closes. The intrapleural pressure is less than the atmospheric pressure. Over a variable period of weeks, air gets absorbed and the lung re-expands fully.
2. **Open pneumothorax** – Here, the site of rupture remains open and is in communication through bronchopleural fistula with outside atmosphere. Hence, the pressure in pleural space is equal to that of atmospheric pressure. Pleural space gets infected secondarily through the opening, resulting in pyopneumothorax. This occurs in rupture of tuberculous lesion that remains open due to fibrous adhesions.
3. **Tension pneumothorax** – Here, the site of rupture is small and valvular so that air enters pleural space during inspiration but cannot come out during expiration. Progressively a large volume of air gets trapped in the pleural space and pressure in the pleural cavity becomes more than that of atmospheric pressure, hence tension pneumothorax. It causes displacement of heart to the opposite side. It is a medical emergency that needs urgent release of trapped air (see Chapter 12).

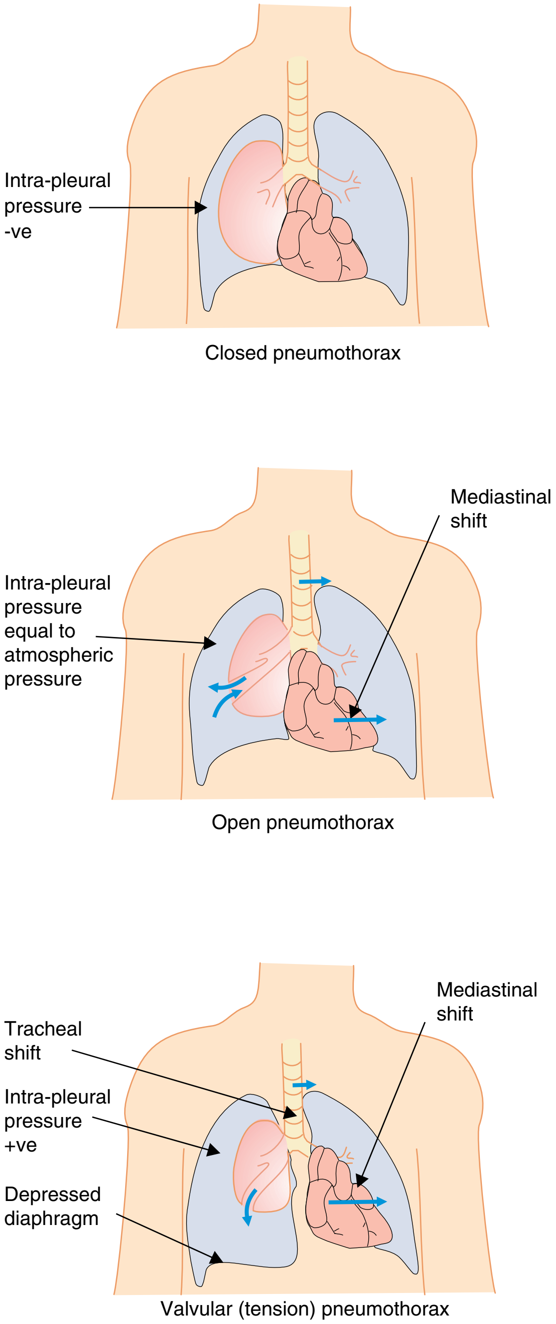

Intra-pleural pressure -ve
Closed pneumothorax
Mediastinal shift
Intra-pleural pressure equal to atmospheric pressure
Open pneumothorax
Mediastinal shift
Tracheal shift
Intra-pleural pressure +ve
Depressed diaphragm
Valvular (tension) pneumothorax

Figure 4.48 Types of spontaneous pneumothorax.

1. **Clinical presentation**
   The signs and symptoms vary with severity and type of pneumothorax, from asymptomatic to life-threatening situations. Patient complains of chest pain and dyspnea of sudden onset, along

with anxiety, sweating and palpitations. Physical signs on the side of pneumothorax are

   - **a.** Intercostal fullness (with tension pneumothorax)
   - **b.** Diminished chest movements with mediastinal shift to the opposite side
   - **c.** Hyperresonant or tympanic percussion note or sometimes cracked-pot percussion note
   - **d.** Absent breath sounds and diminished VR with closed pneumothorax
   - **e.** Amphoric breath sounds with WP in open pneumothorax; VR has a metallic quality
   - **f.** Succussion splash in hydropneumothorax. Patient is febrile and looks more toxic with hydropneumothorax than in spontaneous closed pneumothorax
   - **g.** Positive coin sound test

2. **Investigations**
   - **a.** Chest X-ray (posteroanterior and lateral views) – Air is seen in pleural space. Trachea and heart are displaced to the opposite side in all the three types of pneumothoraces (Fig. 4.49) but more markedly in tension pneumothorax.
   - **b.** Blood – WBC count is increased or normal, Hb is decreased or normal, ESR is increased or normal.
3. **Management** – Supplemental O_2 – It accelerates absorption of air from the pleural cavity.
   - **a. Closed pneumothorax** – For small pneumothorax, no treatment is required as the air gets absorbed. It is advised to repeat X-ray of the chest after 6 and 48 hours to confirm nonprogression of pneumothorax. With large pneumothorax, hospitalize the patient and drain air by pigtail catheter inserted in the 2nd ICS in midclavicular line and aspirate out the air. If lung does not expand, a catheter is inserted and continuous drainage instituted.
   - **b. Open pneumothorax** – This usually results in hydropneumothorax, confirm etiology by diagnostic aspiration and treat as per etiology.
   - **c. Tension pneumothorax** – Urgent drainage with wide-bore plastic cannula inserted in 2nd ICS in midclavicular line anteriorly and connected to water seal drainage system (Fig. 4.50). Antibiotics or antitubercular treatment is instituted as indicated.
   - **d. Recurrent pneumothorax**
     Treatment: pleurodesis
     (i.e. obliteration of pleural space with an irritant like kaolin, tetracycline), failing which videoassisted thoracic surgery is carried out.

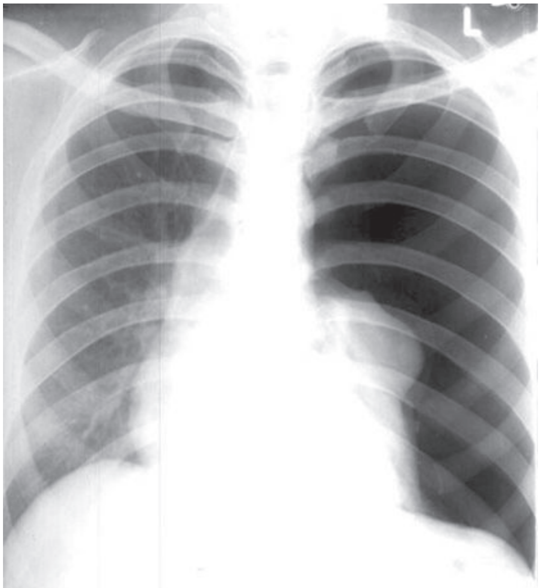


Figure 4.49 Pneumothorax with complete collapse of left lung.

Viva voce

Q1. What is normal intrapleural pressure?

It is −2.5 to −6 mm Hg. At the height of inspiration, it becomes more negative (−6 mm Hg) and during expiratory apnea, it is less negative (−2.5 mm Hg).

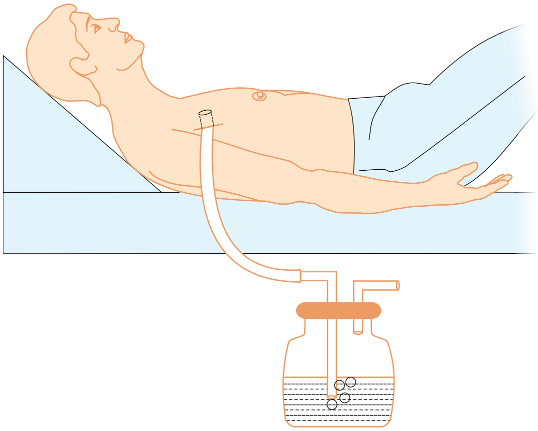


Figure 4.50 Underwater seal drain for treatment of pneumothorax.

A case of hydropneumothorax

This usually occurs when there is rupture of subpleural tuberculous lesion in the lung, resulting in leakage of air along with the development of exudative pleural fluid. One can elicit shifting dullness and succussion splash (Fig. 4.51).

Amphoric breathing and WP are present in the presence of bronchopleural fistula. Bubbling sounds with inspiration are heard when bronchopleural fistula is below the fluid level.

Diseases of mediastinum

Anatomical divisions of mediastinum (superior mediastinum, anterior mediastinum, middle mediastinum and posterior mediastinum) are shown in Fig. 4.52.

Mediastinal tumors mostly arise from various structures in the mediastinum and cause compression of structures within the mediastinum.

1. Superior mediastinal masses – Thymoma, aneurysm of aorta (ascending and arch), retrosternal thyroid, lymph nodes (tuberculosis, lymphoma, secondaries, sarcoidosis, leukemia), esophageal tumor, teratoma, parathyroid tumor
2. Anterior mediastinal masses – Thymoma, lymph nodes (see above), diaphragmatic hernia
3. Middle mediastinal masses – Aortic aneurysm, cardiac tumors, pleuropericardial cyst, bronchogenic cyst, tumors, lymphoma

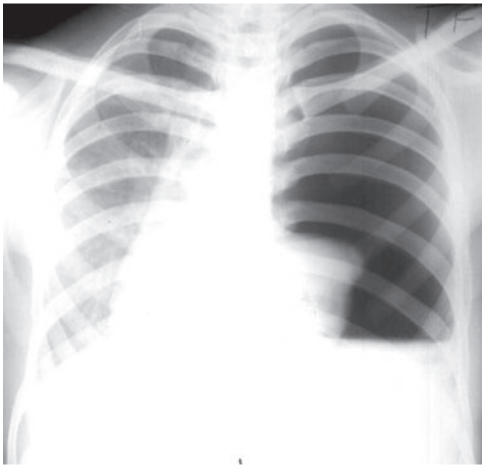


Figure 4.51 Hydropneumothorax with left lung collapse.

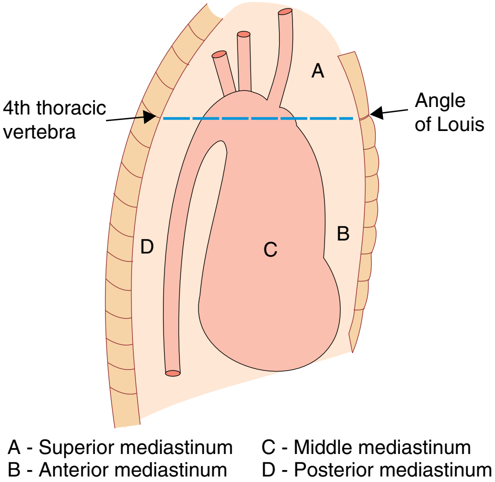


Figure 4.52 Divisions of mediastinum.

4. Posterior mediastinal masses – Aortic aneurysm, neurogenic tumors, cysts including hydatid cyst, diaphragmatic hernia, bronchogenic tumors, enteric cyst, esophageal diverticula, esophageal tumor

A case of superior mediastinal syndrome

1. **Clinical features**
    a. Constitutional symptoms like fever, malaise, loss of weight and cough are present in the case of tuberculous lymph nodes and lymphoma.
    b. Features of mediastinal compression include
        i. Dysphagia (esophagus)
        ii. Cough, breathlessness, stridor (trachea, bronchi)
        iii. Hoarseness of voice (left recurrent laryngeal nerve paralysis)
        iv. Horner's syndrome (sympathetic involvement)
        v. Diaphragmatic paralysis (phrenic nerve paralysis)
        vi. Suffused edematous face and conjunctivae due to pressure over SVC (Fig. 4.53).
        vii. Nonpulsatile distended neck veins (pressure over SVC).
        viii. Distended veins over chest – collaterals with flow from above down

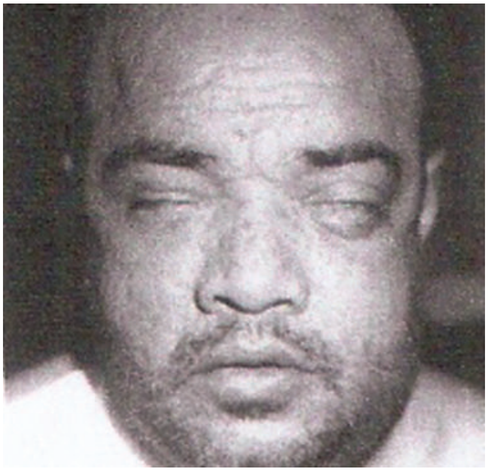


Figure 4.53 Superior mediastinal syndrome (suffused face and conjunctiva).

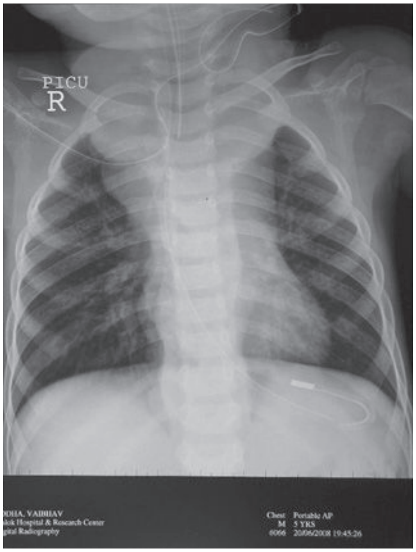


Figure 4.54 Extensive superior mediastinal mass (neurofibroma).

2. **Investigations**
   - **a.** Chest X-ray shows mediastinal mass (Fig. 4.54).
   - **b.** Computed tomography scan and MRI are more useful diagnostic modalities.
   - **c.** Computed tomography guided or mediastinoscopic biopsy of mass is necessary to arrive at the etiological diagnosis (before biopsy aortic aneurysm must be excluded).
3. **Principles of management**
   - **a.** Medical treatment for tuberculosis, lymphoma
   - **b.** Surgery for benign tumors and resectable malignant tumors
   - **c.** Radiotherapy/chemotherapy for malignant tumors

For summary of physical signs in important respiratory diseases, refer Table 4.8.

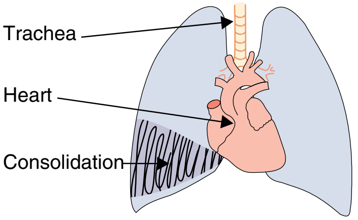
Table 4.8 **Important physical signs in respiratory diseases. (For mediastinal shifts in chest diseases see Fig. 4.55)**

Condition	Inspection	Palpation	Percussion	Auscultation
Consolidation (lobar pneumonia – Fig. 4.56)	Movements reduced on affected side	Movements reduced, increased TVF, no mediastinal shift	Impaired to dull	Bronchial breath sounds (tubular), VR increased, WP+, bronchophony+, fine crackles early, coarse crackles later
Cavity (in an area of consolidation or with a thick wall)	Movements may be slightly reduced	Movements may be slightly reduced, TVF usually increased, mediastinum usually not shifted	Impaired to dull	Cavernous/amphoric breathing, VR increased, WP present, coarse crackles
Collapse of lung with persistent bronchial obstruction	On the side of collapse, retraction and diminished movements	Movements reduced, decreased to absent TVF, trachea, heart shifted to same side	Dull	Decreased to absent breath sounds, VR decreased or absent, no adventitious sounds

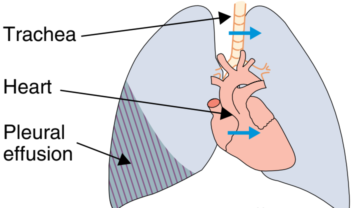
(*Continued*)

Table 4.8 **Important physical signs in respiratory diseases. For mediastinal shifts in chest diseases (see Fig. 4.55) (*Continued*)**

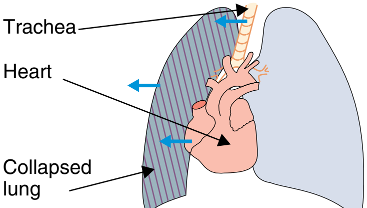
Condition	Inspection	Palpation	Percussion	Auscultation
Acute or chronic bronchitis (without emphysema)	Movements slightly reduced on both sides	Movements slightly reduced on both sides, TVF normal or reduced, no mediastinal shift	Normal resonance	Vesicular breath sounds with prolonged expiration, decreased intensity of breath sounds, VR normal or reduced, expiratory rhonchi/wheezes and coarse crackles
Bronchial asthma	Normal or barrel-shaped chest, movements reduced bilaterally	Movements reduced bilaterally, TVF decreased, mediastinum central	Normal or hyperresonant	Vesicular breathing with prolonged expiration, VR decreased, expiratory wheezes (high pitched)
Emphysema	Barrel-shaped chest, movements reduced on both sides	Barrel-shaped chest (AP > T diameter), movements reduced, TVF decreased on both sides, no mediastinal shift	Hyperresonant, cardiac dullness masked, lower borders of lung shifted down, upper border of liver dullness shifted down	Vesicular breath sounds with prolonged expiration, decreased intensity of breath sounds, VR decreased, expiratory wheezes, crackles ±
Localised pulmonary fibrosis	Retraction on the same side, movements reduced	Retraction on the same side, movements reduced, TVF decreased, mediastinum may be shifted to same side	Impaired to dull	Vesicular, diminished intensity of breath sounds, VR normal or decreased, fine crackles
Pleural effusion	Fullness of ICSs on the same side with large effusion, movements reduced on the same side	Movements reduced, absent or decreased TVF, trachea, mediastinum shifted to the opposite side	Stony dull/flat	Breath sounds decreased or absent, bronchial breath sounds may be present at the upper level of large effusion, VR decreased or absent, egophony, bronchophony, WP may be present at the top of large effusion, pleural rub in acute pleurisy or during resolving stage
Closed pneumothorax	Fullness of ICSs on the affected side, chest movements reduced or absent on the affected side	Movements reduced, TVF decreased or absent, trachea, heart shifted to opposite side	Hyperresonant	Decreased to absent breath sounds, VR decreased or absent, no adventitious sounds, positive coin test
Open pneumothorax	Mild fullness of ICSs, movements reduced	Movements reduced, TVF increased, mediastinum shifted to opposite side	Hyperresonant (cracked pot sound)	Amphoric breathing, VR increased (metallic quality), WP+, positive coin test
Hydropneumothorax	Mild fullness of ICSs, movements reduced	Movements reduced, TVF diminished/absent, mediastinum shifted to opposite side	Shifting dullness	Breath sounds diminished/absent, VR diminished/absent, succussion splash +
Thickened pleura	Reduced movements, mild retraction of chest wall	Movements reduced, TVF reduced, mediastinum shifted to same side	Impaired to dull	Normal vesicular, diminished intensity of breath sounds, VR reduced, no adventitious sounds


Trachea
Heart
Consolidation

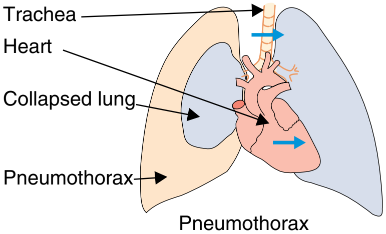
Consolidation
Trachea & heart central


Trachea
Heart
Pleural effusion

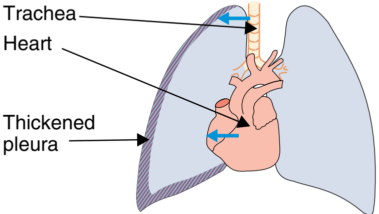
Pleural effusion
Trachea & heart shifted to opposite side


Trachea
Heart
Collapsed lung

Massive collapse
Trachea & heart pulled to the same side


Trachea
Heart
Collapsed lung
Pneumothorax

Pneumothorax
Trachea & heart to opposite side


Trachea
Heart
Thickened pleura

Thickened pleura
Trachea & heart pulled to the same side

Figure 4.55 Mediastinal shifts in chest diseases.

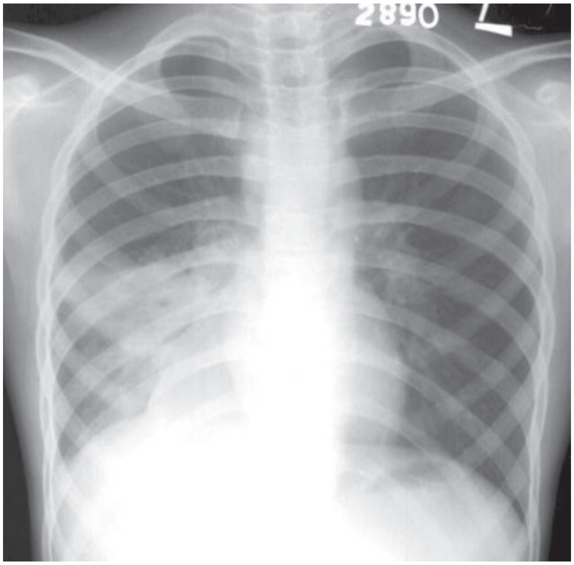


Figure 4.56 Segmental consolidation of right lower lobe loculated pleural effusion.

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Chapter 5

The nervous system

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INTRODUCTION

A systematically conducted neurology examination is most rewarding. One can almost always arrive at a complete diagnosis which includes the site of the lesion (anatomical diagnosis), the functional components affected (physiological diagnosis) and the pathological diagnosis (the possible disease process).

HISTORY

Evolution of symptoms (Fig. 5.1)

1. Sudden onset, rapidly evolving neurodeficit, maximum at the onset, with variable recovery is seen with trauma, vascular accidents, demyelination and acute meningitis.
2. Transient focal weakness is a feature of transient ischemic attacks (TIAs) and Todd's paralysis.
3. Gradually progressive course over months is seen with space-occupying lesions, nutritional disorders and toxins affecting nervous system.
4. Gradually progressive course spanning over years is characteristic of degenerative disorders.
5. Episodic illness with full recovery is seen in epilepsy, migraine and periodic paralysis.
6. Recurrent episodes with variable recovery and often an additive neurodeficit occur in multiple sclerosis (MS), vascular malformations and Behcet's disease.
7. Slowly progressive illness with an episode of sudden worsening indicates development of complication in a slowly progressive disorder, e.g. hemorrhage in a tumor.

Symptoms

A patient may present with a neuro-specific symptom, e.g. paralysis (motor system), ataxia (cerebellar or sensory system) or nonspecific symptom, such as headache and giddiness.

1. Headache – Though a common neurological symptom, it lacks specificity (Fig. 5.2). A variety of diagnostic features can be identified.
   - Acute single episode of headache is seen in acute meningitis and subarachnoid hemorrhage
   - Acute and recurrent headaches is a feature of migraine, cluster headaches and neuralgia
   - Subacute single episode of headache is seen in chronic infection, cerebral abscess and raised intracranial pressure (ICP).
   - Chronic headache is usually due to non-neurologic causes, e.g. tension headache, depression, cervical spondylosis and drugs (overuse of analgesics, oral contraceptives)
2. Seizures – If the seizure is associated with loss of consciousness, historical details should be elicited from an eyewitness. Seizure can be generalized or partial; the latter can be simple or complex. Generalized seizure has a typical pattern of evolution – aura → tonic phase → clonic phase → postictal phase.

   Aura is an unusual feeling or a state of altered mood. In the tonic phase, patient loses consciousness, develops stiffness of muscles and stops breathing. In the clonic phase, there are jerky movements of extremities, biting of tongue and urinary incontinence. The postictal phase is characterized by flaccidity, confusion, severe headache and amnesia of variable duration. There may be history of injury during an attack.

   A focal seizure may remain localized, spread ipsilaterally or spread to the other side with loss of consciousness. It indicates focal cortical lesion (e.g. scar, tumor). In complex partial seizure (usual focus temporal lobe), there is altered mental state (including deja-vu and jamais vu phenomenon), hallucination, abnormal stereotype behavior or emotional disturbance.

   A seizure should be differentiated from syncope and hysteria. Syncope can be associated

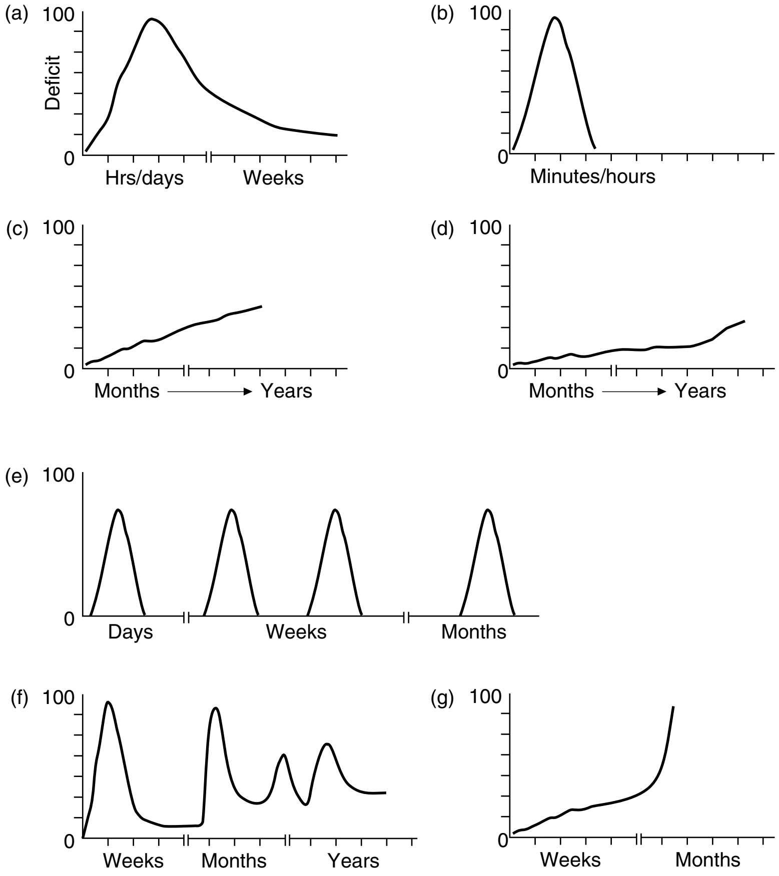


Figure 5.1 Patterns of evolution of neurological symptoms.

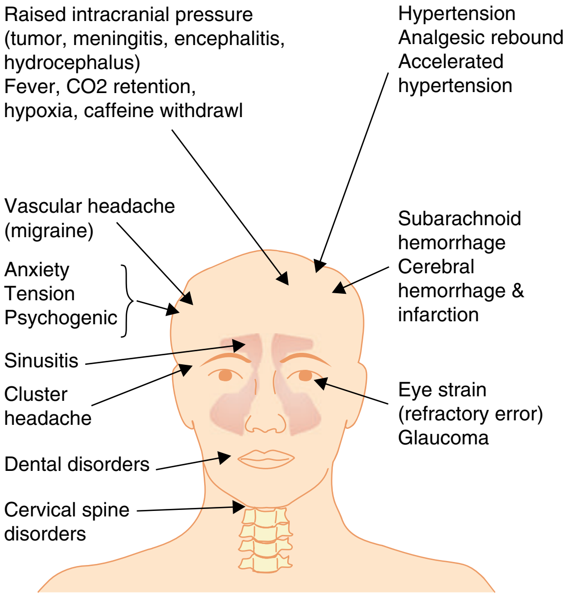

Raised intracranial pressure
(tumor, meningitis, encephalitis,
hydrocephalus)
Fever, CO2 retention,
hypoxia, caffeine withdrawl
Hypertension
Analgesic rebound
Accelerated
hypertension
Vascular headache
(migraine)
Anxiety
Tension
Psychogenic
Subarachnoid
hemorrhage
Cerebral
hemorrhage &
infarction
Sinusitis
Cluster
headache
Eye strain
(refractory error)
Glaucoma
Dental disorders
Cervical spine
disorders

Figure 5.2 Common causes of headache.

with myoclonic jerks and urinary incontinence, thus mimicking a seizure. Cyanosis and biting of tongue are not its features. The loss of consciousness is slower (patient is aware of losing consciousness), and recovery is faster. Hysterical fits do not occur in sleep, or in the absence of a "witness," are bizarre, and last longer; there is no biting of tongue, injury due to fall or urinary incontinence. Faints, funny turns and dizziness have no specific diagnostic significance.

PHYSICAL EXAMINATION

Examination of nervous system includes (1) higher functions, (2) cranial nerves, (3) motor system, (4) sensory system, (5) reflexes and (6) bladder, bowel and autonomic functions.

HIGHER FUNCTIONS

Higher function examination includes mental functions, speech and functions of individual cerebral lobes.

Examine the patient for

1. Appearance, behavior, communication and emotional state
2. Level of consciousness
   a. Consciousness is awareness of environment and ability to respond to internal and external stimuli. Altered states of consciousness are as follows
      i. Drowsiness – Patient appears asleep but cannot be woken up easily. Once awake, he tends to fall off to sleep despite verbal stimulation.
      ii. Stupor – Patient can be aroused only with vigorous stimuli that too for brief periods and incompletely.
      iii. Coma – In coma the state of responsiveness is still less, and in deep coma, patient cannot be aroused and does not respond to painful stimuli.

      Glasgow coma scale is a better instrument to assess the level of consciousness. It consists of three weighted components (Box 5.1). The best score is 15, and the worst score is 3.
3. Orientation in time, place and person. Disorientation is an important sign of organic brain disease. Ask relevant questions vis-à-vis time, date, place etc.
4. Delusions and hallucinations
   a. Delusions – Delusions are usually a manifestation of nonorganic psychosis where false beliefs are held despite evidence to the contrary.
   b. Hallucinations – These are false impressions referred to the special senses (taste, smell, sounds) for no detectable cause. The patient is aware of their nonexistence. Hallucinations of taste and smell (a feature of temporal lobe epilepsy) are often stereotyped.
   c. Delirium tremens – It is a form of acute insanity (due to alcohol) marked by sweating, tremor, restlessness, anxiety, mental confusion and hallucinations.

Glasgow coma scale **Box 5.1**

Eye opening

▪ Spontaneous	– 4
▪ To speech	– 3
▪ To pain	– 2
▪ None	– 1

Best verbal response

▪ Oriented	– 5
▪ Confused	– 4
▪ Inappropriate	– 3
▪ Incomprehensible	– 2
▪ None	– 1

Best motor response

▪ Obeys commands	– 6
▪ Localizes pain	– 5
▪ Normal withdrawal	– 4
▪ Abnormal flexion	– 3
▪ Abnormal extension	– 2
▪ None	– 1

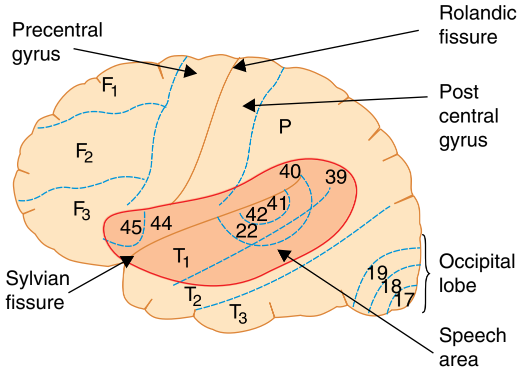
Memory

Memory is the ability to grasp and retain new information. It is of three types.

1. Immediate or short-term memory – It pertains to events of a few seconds duration. It is impaired in acute confusion, Wernicke–Korsakoff psychosis and Alzheimer's dementia. To test short-term memory, check digit span (seven forward or five backward) or ask the patient to spell a word backward.
2. Recent memory – It involves recall of events of up to a few days. It is lost in dementia, acute confusional states and amnesia. Ask patient to recall recent events or information.
3. Long-term memory or past memory – It concerns past events. Enquire about past details (events, information).

Speech and language – cortical organization of speech

The speech area is distributed over frontal, parietal and temporal lobes of the dominant hemisphere (Fig. 5.3). In right-handed individuals, it is situated on the left side. In left-handed individuals, it can be on either side.



44, 45	Broca's area (motor aphasia)
41, 42	Auditory area
22	Wernicke's area (Wernicke's aphasia)
40	Supramarginal gyrus (Gerstmann's syndrome)
39	Angular gyrus (alexia, agraphia)
17, 18, 19	Visual cortex

F - frontal lobe, T - temporal lobe, P - parietal lobe

Figure 5.3 Speech areas.

1. Motor speech area (Broca's area) – It is situated in the posterior most portion of inferior convolution of the frontal lobe, in front of the precentral gyrus. Its affection may cause total loss of ability to speak; lesser affection manifests as poorly articulated, nonfluent, telegraphic speech.
2. Sensory speech area (Wernicke's area) – It is situated in the posterior part of area 22 and the parietotemporal junction. Its functions include comprehension of speech and selection of words to express ideas. Lesions of Wernicke's area result in receptive or sensory aphasia. There is inability to comprehend auditory and visual symbols. The speech is fluent with correct articulation but with inappropriate words. The disturbance may be restricted to spoken speech (temporal lobe lesion) or written speech (parietooccipital lesion).

Disturbances of speech (articulation)

Dysarthria

Types of dysarthria

1. Stammering – This is a developmental disorder, more common in boys. It is not a sign of organic brain disorder.
2. Baby speech – It is characterized by dropping of difficult consonants, usually due to congenital or infantile deafness.
3. Cerebellar dysarthria – It is of two types (1) scanning dysarthria – the speech is slow and spoken syllable by syllable often with each syllable emphasized equally and (2) staccato speech – the speech is explosive with slurring of characters.
4. Pseudobulbar (spastic) dysarthria – It is due to bilateral corticospinal involvement. Individual syllables are slurred. In extreme affection, patient may become speechless (aphonic).
5. Aphonia – It can be a feature of hysteria. However, a hysterical patient phonates during spontaneous or voluntary coughing or while singing, which is not possible in pseudobulbar palsy.
6. Bulbar dysarthria – It is due to involvement of lower motor neurons (LMNs) that control speech musculature. Dysphagia is often present.

Aphasia

Types

1. Aphasia is disturbance of comprehension and production of spoken and written speech.
2. Dysphasia is partial speech defect.
3. Global aphasia is total loss of speech function. It results from infarction in the territory of middle cerebral artery.

Language – It is the ability to communicate and express cerebral activities and learning in an orderly and correct manner. Its disorders are as follows:

- Agraphia – Inability to write.
- Alexia – Inability to read.
- Word deafness – Difficulty in understanding the meaning of spoken speech.
- Paraphasia – Missing of simple syllabic or word elements with substitution so as to approximate desired response.

Aphasia localizes lesion to the dominant hemisphere.

Apraxia

Apraxia is inability to perform voluntary actions, even though there is no evidence of sensory or motor disturbance. Patient is able to perform individual components of the action.

Manifestations of dysfunction of cerebral lobes

Frontal lobe

- Motor area – Convulsions and contralateral upper motor neuron (UMN) paralysis
- Broca's area – Motor aphasia
- Prefrontal area – Personality disorders

Parietal lobe

- Sensory area – Contralateral astereognosis
- Speech area – Sensory aphasia, apraxia and Gerstmann's syndrome (acalculia, right-left disorientation, finger agnosia and agraphia)

Temporal lobe

- Non dominant lobe – Loss of acuity for music
- Dominant side – Disturbance of memory, language and recognition
- Medial limbic area – Partial complex seizures, personality changes and loss of libido in males

Occipital lobe

- Lesions of primary visual cortex cause central blindness. Occipital seizures can manifest as visual hallucinations

CRANIAL NERVES

First cranial nerve

Anatomy

Olfactory nerve carries the sense of smell. Its fibers arise from olfactory epithelium of the nose and then pass through the cribriform plate to the olfactory bulb. From here, fibers project on to uncus and parahippocampal gyrus, (the olfactory centers).

Examination

Use familiar smells like oil of clove, oil of peppermint, tincture of asafetida, and scents. Avoid irritants like ammonia, which stimulate trigeminal nerve. Test each nostril separately. Exclude nasal block or inflammation. The abnormalities can be (1) anosmia – absence of sense of smell, (2) parosmia – pleasant odors seem offensive and (3) hallucinations of smell, which may be part (aura) of temporal lobe seizure.

Causes of anosmia

Common causes of anosmia are

- Sinusitis
- Head injury involving cribriform plate
- Subfrontal lobe tumors (e.g. meningioma)
- Basal meningitis
- Aging
- HIV infection
- Drugs (antibiotics, copper chelating agents)

Second cranial nerve

Anatomy

The visual pathways are shown in Fig. 5.4

Note

1. Nasal fibers decussate at the chiasma.
2. Optic tracts and optic radiation carry visual impulses of ipsilateral nasal and contralateral temporal fields of vision. Therefore, right occipital cortex represents left half of field of vision and left occipital cortex the right half of field of vision.
3. Macular vision is represented at the occipital poles.

Examination of optic nerve

Visual acuity

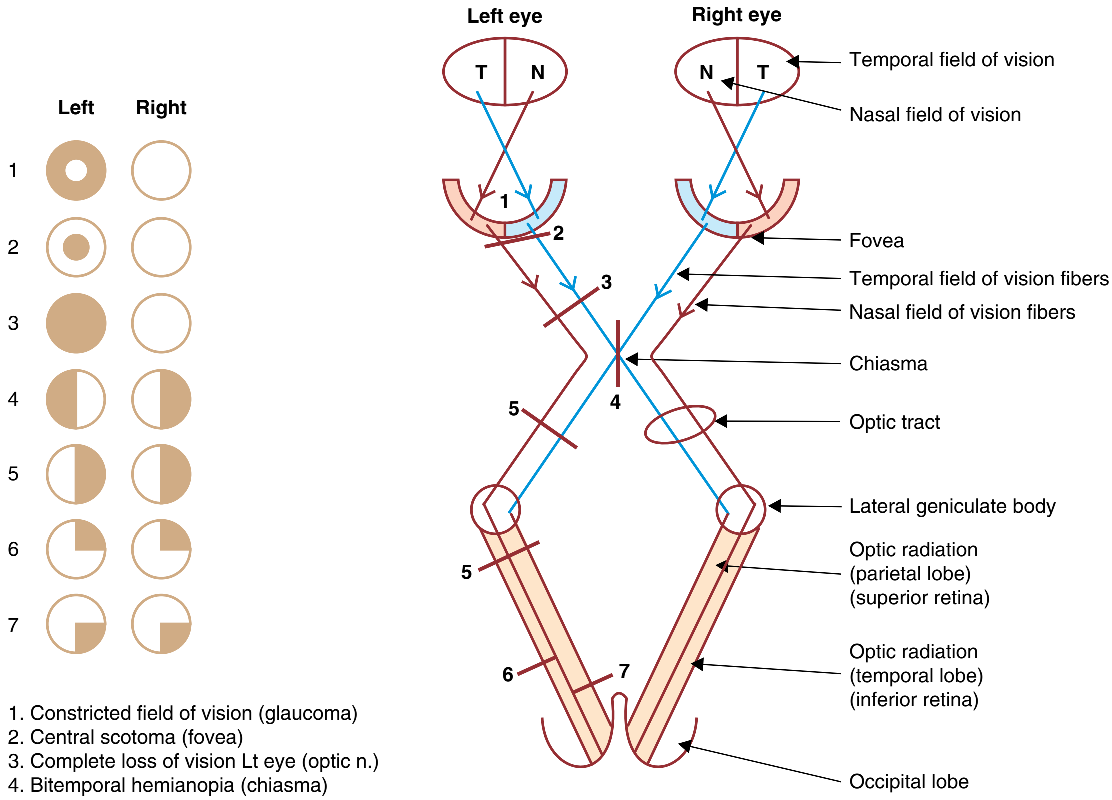
Snellen's test charts are used to test visual acuity. Normal acuity is 6/6. Visual acuity of less than 1/60 is measured by the ability of the patient to count fingers, perceive light (perception of light [PL]), or hand movements.

Visual fields

The field of vision is wider for bigger objects and white light. Color vision is restricted to central or macular vision. Moving objects are perceived better in the peripheral field of vision. Form and details are perceived better in the central field of vision.

Confrontation test

Sit at a distance of about 1 m from the patient with the patient's eyes at the same level as yours (Fig. 5.5). Ask the patient to cover one eye with his hand and cover your corresponding eye (e.g. patient's right eye and your left eye). Watch patient's eyes for any eye movement. Hold your index finger at full-arm distance in a plane midway between yourself and the patient and check if both, the patient and you can see the finger or its movement (wriggle the finger). If not, move the finger inward slowly and note the distance at which the patient perceives the finger and compare it with yours. In this fashion, test all the four quadrants of visual field. Repeat the same procedure with the other eye. In this test, the examiner's field of vision acts as the normal control. A more accurate method is perimetry. A red pin is used to test physiologic blind spot (corresponds to point of entry of optic nerve into the retina).


Left
Right
1
2
3
4
5
6
7
Left eye
Right eye
T
N
N
T
Temporal field of vision
Nasal field of vision
1
2
3
4
5
5
6
7
Fovea
Temporal field of vision fibers
Nasal field of vision fibers
Chiasma
Optic tract
Lateral geniculate body
Optic radiation (parietal lobe) (superior retina)
Optic radiation (temporal lobe) (inferior retina)
Occipital lobe

1. Constricted field of vision (glaucoma)
2. Central scotoma (fovea)
3. Complete loss of vision Lt eye (optic n.)
4. Bitemporal hemianopia (chiasma)
5. Rt homonymous hemianopia (Left optic tract + optic radiation)
6. Rt superior quadrantanopia (temporal radiation)
7. Rt inferior quadrantanopia (parietal radiation)

Figure 5.4 Visual pathways and visual field defects.

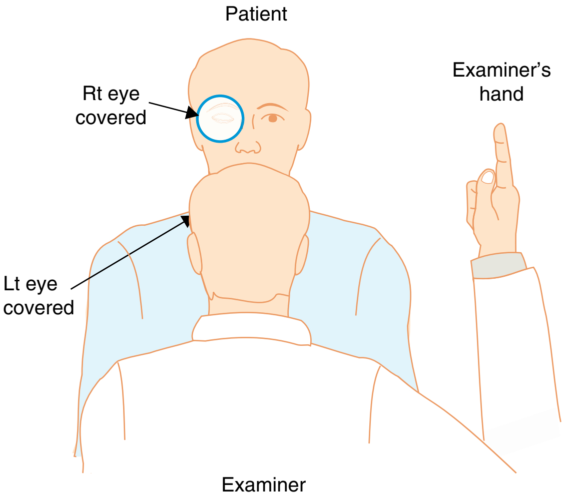

Patient
Rt eye covered
Examiner's hand
Lt eye covered
Examiner

Figure 5.5 Confrontation test.

Visual field defects (Fig. 5.4)

1. Central scotoma due to optic neuritis.
2. Paracentral scotoma, i.e. loss of vision near macula, due to diseases of retina and choroid. Unilateral scotoma is usually vascular in origin. Bilateral scotoma are usually due to toxins or B12 deficiency. Paracentral arcuate scotoma is typical of glaucoma.
3. Hemianopia is loss of vision of one half of field of vision (nasal or temporal).
4. Homonymous hemianopia is loss of same halves of fields of vision (nasal or temporal) of both the eyes.
5. Quadrantic hemianopia is blindness limited to a quadrant of visual field.
6. Superior and inferior altitudinal hemianopia (quadrantanopia) is loss of upper and lower visual fields respectively. Unilateral visual loss is usually due to optic nerve lesions, while bilateral loss is due to occipital lobe lesions (uncommon).

7. Bitemporal hemianopia is loss of temporal halves of fields of vision of both eyes due to lesions at optic chiasma involving decussating fibers, e.g. by tumor, inflammation, trauma.
8. Binasal hemianopia is bilateral loss of nasal halves of fields of vision. It is rare. The causes are glaucoma and lesions involving temporal fibers at the chiasma.
9. Concentric loss of field of vision results from long-standing papilledema, lesions of striate cortex and retinitis pigmentosa.
10. In bilateral occipital infarcts, only macular vision is preserved.
11. Tunnel vision is constricted field of vision that remains same when tested at various distances. It is a manifestation of hysteria. Normally, the field of vision widens as the distance from the eyes increases.
12. Complete loss of vision in one eye is due to optic nerve lesion.

Third, fourth and sixth cranial nerves

Anatomy

Cranial nerves III (oculomotor), IV (trochlear) and VI (abducens) control external ocular movements (EOM) and the pupillary reaction. Their nuclei are located in the brain stem close to the aqueduct, extending from the level of superior corpora quadrigemina to the floor of the 4th ventricle in upper pons. Nucleus of III cranial nerve lies most rostrally and of VI nerve lies most caudally. Edinger–Westphal nucleus (EWN) is situated most rostrally. It provides parasympathetic outflow to ciliary muscle and iris. Caudal to EWN lie nuclei innervating levator palpebrae superioris (LPS), superior rectus (SR), medial rectus (MR), inferior rectus (IR) and inferior oblique (IO) muscles, in that order. The III cranial nerve emerges on the anterior aspect of brain stem between midbrain and pons. In its course, it lies close to cerebral peduncle, posterior cerebral artery and posterior communicating artery before passing through the lateral wall of cavernous sinus to enter superior orbital fissure (SOF) (Figs. 5.6 and 5.7).

The fibers of IV cranial nerve decussate before emerging on the dorsal aspect of brain stem. Thus, the right IV cranial nerve nucleus innervates opposite superior oblique (SO) muscle. The nerve courses round the brain stem and passes through cavernous sinus and enters the orbit through SOF (Fig. 5.8).

The VI cranial nerve emerges anteriorly between pons and medulla, passes through the cavernous sinus and enters the orbit through SOF. Its long course makes it particularly vulnerable to external pressure.

Examination of III, IV and VI cranial nerves

External ocular movements (EOM)

The external ocular movements are adduction, abduction, elevation, depression and internal and external rotation (Fig. 5.9). Internal rotation and

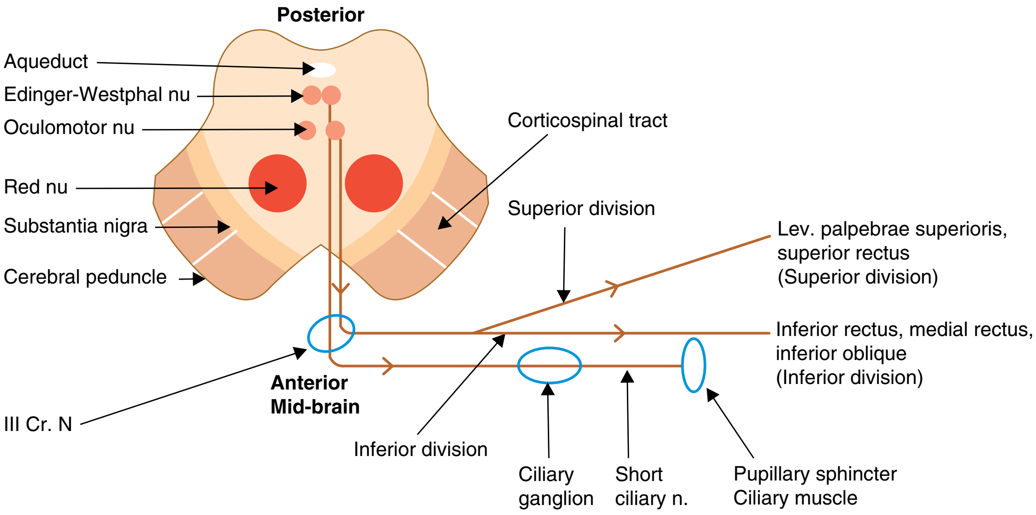

Posterior
Aqueduct
Edinger-Westphal nu
Oculomotor nu
Red nu
Substantia nigra
Cerebral peduncle
Corticospinal tract
Superior division
Lev. palpebrae superioris, superior rectus (Superior division)
Inferior rectus, medial rectus, inferior oblique (Inferior division)
Anterior Mid-brain
III Cr. N
Inferior division
Ciliary ganglion
Short ciliary n.
Pupillary sphincter Ciliary muscle

Figure 5.6 III Cranial nerve.

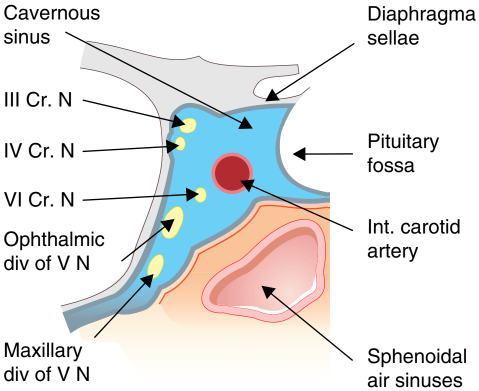

Cavernous sinus
III Cr. N
IV Cr. N
VI Cr. N
Ophthalmic div of V N
Maxillary div of V N
Diaphragma sellae
Pituitary fossa
Int. carotid artery
Sphenoidal air sinuses

Figure 5.7 Coronal section of cavernous sinus.

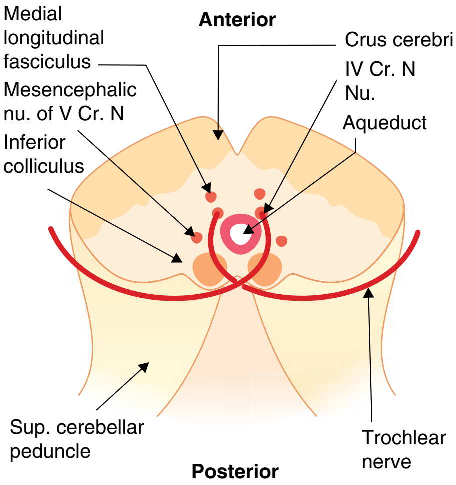

Medial longitudinal fasciculus
Mesencephalic nu. of V Cr. N
Inferior colliculus
Anterior
Crus cerebri
IV Cr. N Nu.
Aqueduct
Sup. cerebellar peduncle
Posterior
Trochlear nerve

Figure 5.8 VI cranial nerve.

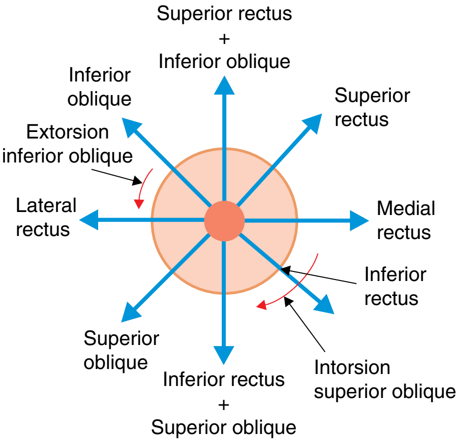

Superior rectus + Inferior oblique
Inferior oblique
Superior rectus
Extorsion inferior oblique
Lateral rectus
Medial rectus
Inferior rectus
Superior oblique
Intorsion superior oblique
Inferior rectus + Superior oblique

Figure 5.9 Actions of external ocular muscles with eye in neutral position (right eye).

external rotation are not under voluntary control but occur reflexly to compensate for head tilt during activities such as reading.

The axes of the external ocular muscles are such that SR and IR, respectively, act as pure elevators and depressors of the eye with the eye in abducted position. Similarly, IO and SO, respectively, act as pure elevators and depressors with the eye in adducted position. MR and LR act in horizontal plane. Internal and external rotation movements are due to actions of SO and IO, respectively, when the eye is in abducted position. This is the only movement due to SO possible in the presence of III cranial nerve palsy.

External ocular movements are conjugate so that their visual axes meet at the point of focus. External ocular movements are integrated in the brain stem. The higher centers for horizontal conjugate eye movements are situated in the opposite cortex. Conjugate upward and downward movements are under bilateral control. Frontal lobes control upward and occipital lobes control downward movement (Fig. 5.10). Nuclear and infranuclear lesions result in weakness of individual muscles. Supranuclear lesions impair conjugate eye movements.

Other eye movements

Pursuit movements are slow conjugate eye movements while following a moving object. These are often lost in spinocerebellar disorders.

Ocular nerve palsies

III cranial nerve

Complete paralysis of III cranial nerve results in

- Ptosis that masks diplopia, unless the upper eyelid is manually lifted (Fig. 5.43)
- Outward and downward position of the eye ball (unopposed action of LR and SO)
- Abduction and a little downwards are the only eye movements possible
- Internal rotation due to the action of SO (in the abducted eye position, SO cannot act as a depressor of the eye ball but causes internal rotation of the eye).
- Loss of accommodation and light reflex (due to loss of efferent component). In partial III cranial nerve palsy papillary reflex (PR) is preserved.

IV cranial nerve

Paralysis of IV cranial nerve results in impaired downward movement. On attempted downward

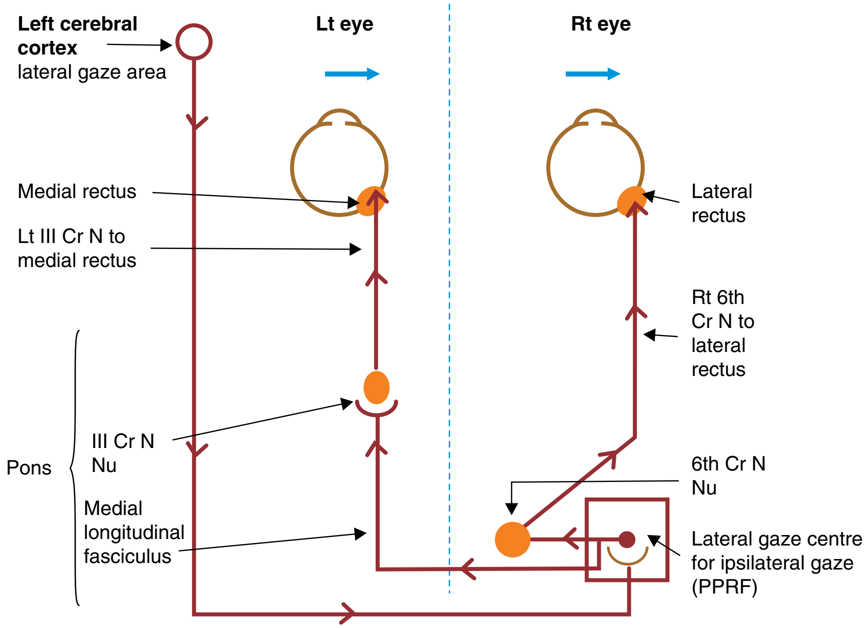

Left cerebral cortex
lateral gaze area
Lt eye
Rt eye
Medial rectus
Lt III Cr N to medial rectus
Lateral rectus
Rt 6th Cr N to lateral rectus
Pons
III Cr N Nu
Medial longitudinal fasciculus
6th Cr N Nu
Lateral gaze centre for ipsilateral gaze (PPRF)

Figure 5.10 Control of lateral conjugate movements.

movement, the eye ball rotates outward due to unopposed action of IR.

VI cranial nerve

Signs of paralysis of VI cranial nerve are absence or incomplete abduction of the eye, diplopia on looking to the side of paralysis and convergent squint due to unopposed action of MR.

Symptoms of EOM paralysis are diplopia, squint and vertigo.

Diplopia

Diplopia (double vision) can be uniocular or binocular. Uniocular diplopia is due to local causes. In binocular diplopia, there is a true image (normal eye image) and a false image (paralyzed eye image). The false image is usually indistinct. Red glass test is performed to identify the paralyzed muscle.

Squint (strabismus)

Squint or strabismus results when the axes of the two eyes do not meet at the point of fixation. Squint may be paralytic or concomitant (nonparalytic). Diplopia is present only in paralytic squint and often in the early stages only (over time the false image gets suppressed).

The two can be distinguished as follows:

Paralytic squint	Concomitant squint
• Paralysis of external ocular movement	• Absence of paralysis of EOM
• Primary and secondary angle of deviation differ	• Primary and secondary angles of deviation same
• Diplopia present	• No diplopia
• Onset any age	• Onset early in childhood
• Normal vision of the squinting eye	• Defective vision of the squinting eye.

Vertigo

Vertigo or dizziness is due to mismatch in the location of images of the two eyes.

Pupils

Examine pupils for the following:

Abnormalities of size and shape

- Size – Slight difference in the size of the two pupils is normal. When significant, the pupil that responds poorly to light is abnormal.
- Shape – Irregular pupils suggest old iridocyclitis.

Pupillary (light) reflex

Afferent fibers of pupillary light reflex (PLR) arise in the retina, travel in the optic nerve, decussate partially at optic chiasma and leave the optic tracts to synapse in geniculate bodies (Fig. 5.11). From here, fibers relay to pretectal area in the brain stem and synapse with EWN. The efferent fibers arising from EWN travel along the oculomotor nerves and synapse in ciliary ganglia before innervating papillary sphincters.

Direct LR

Test each eye separately with the other eye covered. Ask the patient to look straight ahead at a distant point (to overcome accommodation). Flash bright light in the eye. Normally, pupil contracts briskly.

Consensual LR

When light is flashed in one eye, the opposite pupil contracts even if protected from light. This is consensual light reflex. The abnormalities of direct and consensual light reflex are shown in Box 5.2.

Interpretation of pupillary light reflex **Box 5.2**

Pupillary reaction	Interpretation
■ Direct PLR present in both eyes	Normal PLR both eyes
■ Direct PLR absent or weak with normal consensual reflex	Lesion in afferent arc (ipsilateral cranial nerve II)
■ Both direct and indirect PLR weak or absent	Lesion in efferent arc (ipsilateral cranial nerve III)

Accommodation reaction

When focused on a near object, eyes converge and pupils contract. To test accommodation reaction, ask the patient to look at a distant object and then quickly at your finger held close to patient's nose or at the tip of his nose. Accommodation reaction may be lost in brain stem and oculomotor lesions and impaired with autonomic neuropathy.

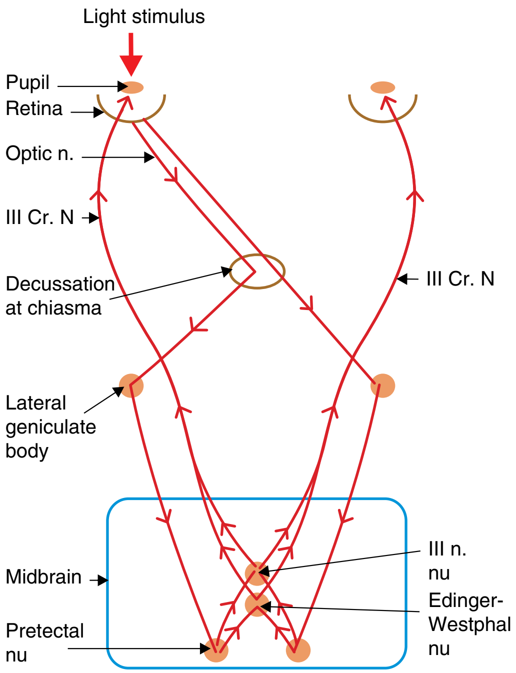


Figure 5.11 Direct and indirect (consensual) pupillary light reflex (LR).

Argyll Robertson pupil (AR pupil)

It is characterized by

- Miosis (small pupil)
- Irregular
- Absence of direct and consensual LR
- Preserved accommodation reaction
- Slow response to locally instilled atropine

Typically both eyes are affected (may be unequally). The lesion is in the pretectal region of mesencephalon. The most classical cause is neurosyphilis, others being diabetes mellitus, alcoholic polyneuropathy and tumor of pineal gland.

Adie's tonic pupil

It can be confused with AR pupil. Its features are

- Absent or delayed pupillary contraction in response to light
- Absent or delayed pupillary contraction to accommodation or convergence
- Once constricted, the pupil dilates slowly in darkness or on looking at a distant object
- Pupillary size varies from day to day
- Often unilateral
- Sometimes associated with absent tendon reflexes (Holmes–Adie syndrome)
- Constricts on local instillation of 2% methacholine (AR pupil does not)
- Due to partial parasympathetic denervation
- Of little clinical significance

Horner's syndrome

Horner's syndrome results from paralysis of cervical sympathetic. The cervical sympathetic fibers originate at C8–T1 spinal segmental level from intermediolateral columns and reach the sympathetic ganglia via rami communicantes. From here, fibers traverse along the internal carotid artery to cavernous sinus and then along the ophthalmic division of V cranial nerve to the eye. The syndrome is characterized by

- Small pupil
- Mild ptosis
- Enophthalmos
- Diminished sweating over head, face, neck, upper limb, upper part of chest up to 3rd rib and back up to 3rd thoracic spine
- Absent ciliospinal reflex (normally, there is dilatation of pupil when skin over neck is pinched or scratched). The reflex is sometimes lost with lesions of cervical and thoracic cord and the medulla.

Gaze palsy

It is a supranuclear palsy due to lesion involving centers controlling conjugate eye movements (Fig. 5.9). It affects both eyes. The patient fails to move the eyes in a specific direction.

- Unilateral lesion of cortical center results in paralysis of gaze to the opposite side
- With unilateral pontine lesion (at the level but not involving the nucleus of VI cranial nerve), there is paralysis of gaze to the same side
- With bilateral frontal lesions, upward eye movements are lost
- With bilateral occipital lesions, downward eye movements are lost
- Irritative lesions produce opposite phenomenon

Internuclear ophthalmoplegia (INO) – INO results from lesion of medial longitudinal fasciculus interrupting connections between nucleus of LR of the same side and the nucleus of MR of the opposite side (Fig. 5.10). When the patient is asked to look to the opposite side of the lesion, there is rhythmic nystagmus of the abducting eye with impaired adduction of the other eye. Thus with lesion of right medial longitudinal fasciculus, when patient attempts to look to the left side, there is impaired adduction of the right eye along with nystagmus of the left eye. The patient may complain of diplopia. Other eye movements including accommodation are preserved. The lesion is on the side with impaired adduction. Internuclear ophthalmoplegia is characteristically but not exclusively seen in multiple sclerosis. It can be bilateral.

Nystagmus

Nystagmus is an involuntary conjugate movement of both eyes. It often has a rhythmic and oscillatory character. The slow component consists of slow drift of the eyes away from the direction of gaze and a quick (corrective) movement is in the direction of gaze. The quicker movement is conventionally the direction of the nystagmus and corresponds to the side of the lesion (in the cerebellum or brain stem). Nystagmus can be horizontal (most common), vertical or rotatory. To test nystagmus, first ask the patient to look straight ahead and note steadiness or otherwise of eyes. Then ask the patient to look at your finger held to left, right, up and down and note the presence or absence of nystagmus.

Nystagmus of neurogenic origin can be due to peripheral (labyrinthine) or central (cerebellar, brain stem) disorders. Differences are given in Box 5.3.

Non-neurogenic types of nystagmus are (1) congenital – it has a pendular quality, (2) positional nystagmus – it is seen in benign epidemic vertigo as a self-limited disorder, (3) normal – it is seen as a few irregular jerky movements of a brief duration on full lateral movement of the eyes and (4) optokinetic nystagmus – it is evoked when eyes follow a moving object and then come back rapidly

Differences between central and peripheral labyrinthine nystagmus

Box 5.3

Peripheral (labyrinthine) nystagmus	Central (cerebellar, brain stem) nystagmus
Unidirectional	Bi or unidirectional; can be vertical
Usually has a rotary component	Horizontal ± rotary
Inhibited by visual fixation	Not inhibited by visual fixation
Direction of nystagmus opposite to the side of the lesion (fast component away from the side of lesion)	Gaze dependent. When unidirectional, fast component is to the side of the lesion
Associated with tinnitus, vertigo, nausea, vomiting, staggering and pastpointing	

to the primary eye position. The most common example is while travelling in a train and observing static objects going by.

Other eye movements

Pursuit movements are slow conjugate eye movements while following a moving object (visual fixation). These are often lost in spinocerebellar disorders. Saccades are quick eye movements toward the object of interest.

V cranial nerve (Trigeminal nerve)

Anatomy

The V cranial nerve has a motor and a sensory component. The sensory fibers originate in the trigeminal (gasserian) ganglion. Sensory root starts from the ganglion and enters pons in its middle part. Fibers carrying sensations of light touch end in the principal sensory nucleus situated lateral to the motor nucleus, near the floor of the 4th ventricle (Fig. 5.12). From here, quintothalamic tract crosses to the opposite side and ends in the thalamus. Fibers subserving pain and temperature enter ipsilateral descending tract of the V cranial nerve, which extends up to the 2nd cervical segment of the spinal cord. From here, the fibers cross to the opposite side, ascend up the medial lemniscus and end in thalamus. In the descending tract, face is represented upside down. Therefore, in lesions of the cervical cord, sensations of upper part of the face are affected (Fig. 5.13).

Divisions of V cranial nerve (Fig. 5.14)

The V cranial nerve has three sensory divisions (ophthalmic, maxillary and mandibular).

1. Ophthalmic division – It innervates scalp up to the vertex, the forehead, upper eye lid,

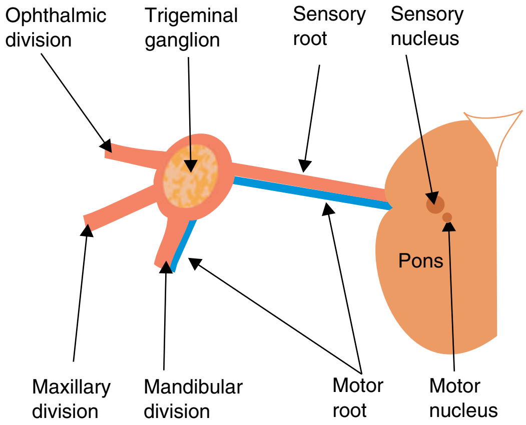

Ophthalmic division
Trigeminal ganglion
Sensory root
Sensory nucleus
Pons
Maxillary division
Mandibular division
Motor root
Motor nucleus

Figure 5.12 V cranial nerve.

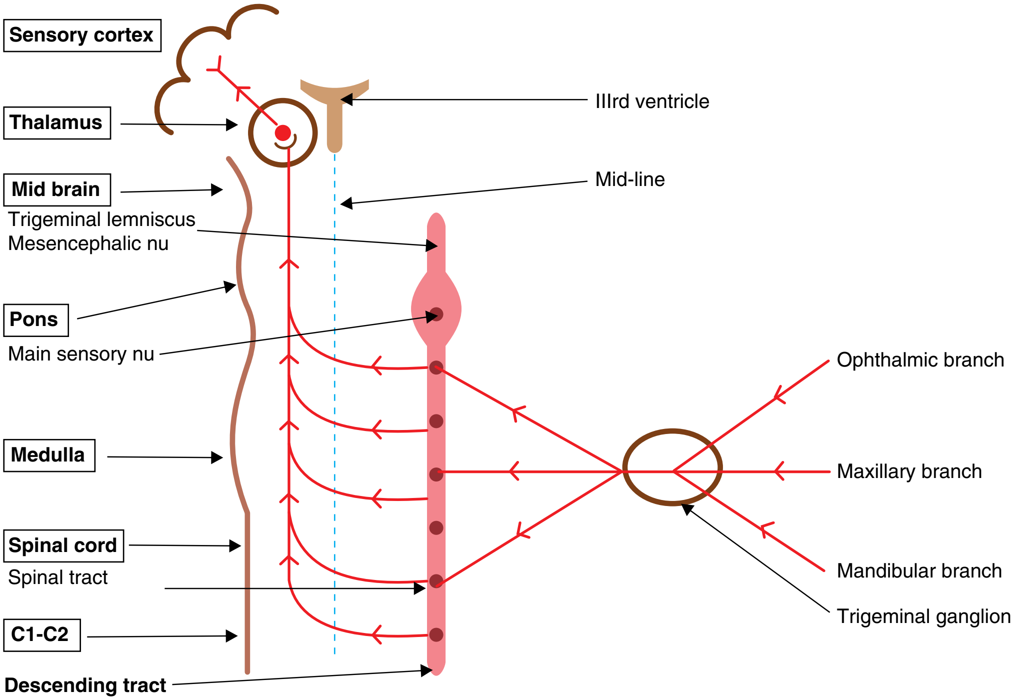

Sensory cortex
Thalamus
IIIrd ventricle
Mid brain
Mid-line
Trigeminal lemniscus
Mesencephalic nu
Pons
Main sensory nu
Ophthalmic branch
Medulla
Maxillary branch
Spinal cord
Spinal tract
Mandibular branch
Trigeminal ganglion
C1-C2
Descending tract

Figure 5.13 Sensory connections of V cranial nerve.

lacrimal gland, conjunctiva (except that of the lower eye lid), cornea and mesial part of skin of nose as far as its tip. With lesions of the ophthalmic division, corneal and conjunctival reflexes are lost.

2. Maxillary division – It innervates lower eye lid and its conjunctiva, inferomedial quadrant of cornea, medial side of the nose and the nasal mucosa, the cheek, the front of the temple, upper lip, upper teeth, the roof of mouth, upper part of pharynx, part of soft palate and tonsils.
3. Mandibular division – It innervates the lower lip, the lower part of the face sparing the angle of jaw, the lower teeth, ear and tongue. It carries parasympathetic fibers to salivary gland and also supplies muscles of mastication. The motor fibers arise from the motor nucleus situated in the pons, near the floor of the 4th ventricle, medial to the sensory nucleus, and from the scattered nuclei situated around the aqueduct. The motor fibers emerge on the lateral aspect of pons, in front of the sensory division and pass below the gasserian ganglion to join the mandibular division.

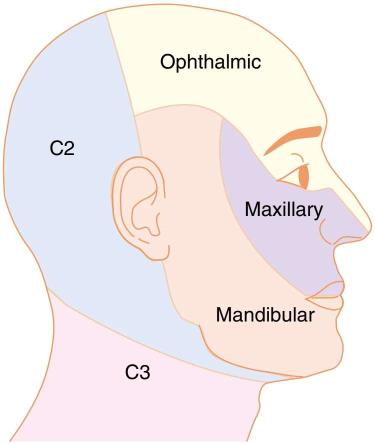

Ophthalmic
C2
Maxillary
Mandibular
C3

Figure 5.14 V cranial nerve, sensory innervation of face.

Clinical features of paralysis of V cranial nerve

1. Loss of sensations in the areas of distribution of all the three divisions
2. Loss of corneal and conjunctival reflexes
3. Decreased salivary, buccal and lacrimal secretions
4. Trophic ulcers (mouth, nose and cornea; neuropathic keratitis)
5. Weakness of muscles of mastication

Examination of v cranial nerve

Sensory functions

Test pain, and touch sensations in the areas of distribution of branches of trigeminal nerve.

Motor functions

1. Note masseter and temporalis muscle mass (wasted with affection of mandibular division) by inspection and by asking the patient to clench his teeth and simultaneously palpating the muscles.
2. In the presence of weakness of lateral pterygoids when the patient opens his mouth, the jaw deviates to the paralyzed side. Gentle resistance to mouth opening brings out mild weakness more clearly.

Reflexes

1. Corneal reflex – Ask the patient to look at a distant object or upward. Touch the edge of the cornea (at the conjunctival margin) with a wisp of cotton. (It helps to steady ones hand by resting little finger on patient's cheek.) Normally, there is brisk closure of both the eyes. Absent or poor reflex suggests affection of V or VII cranial nerve (afferent and efferent arcs).
2. Jaw jerk (see reflexes) – It may not be present in normal individuals. It is exaggerated in pseudobulbar palsy.

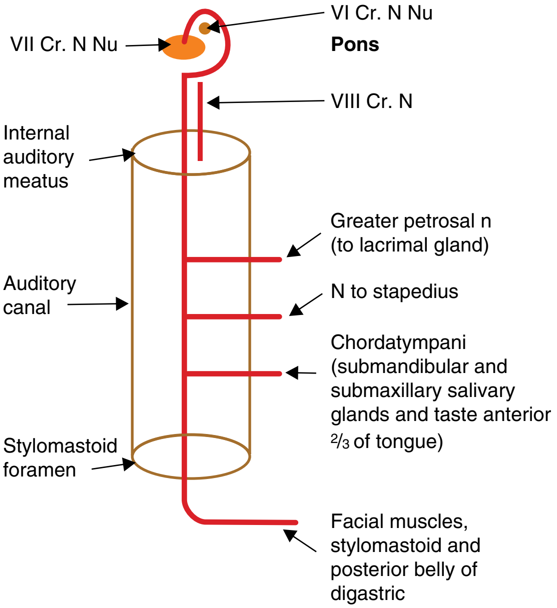

VII Cr. N Nu
VI Cr. N Nu
Pons
VIII Cr. N
Internal auditory meatus
Greater petrosal n (to lacrimal gland)
Auditory canal
N to stapedius
Chordatympani (submandibular and submaxillary salivary glands and taste anterior 2/3 of tongue)
Stylomastoid foramen
Facial muscles, stylomastoid and posterior belly of digastric

Figure 5.15 VII cranial nerve.

3. Glabellar reflex – It is elicited by tapping glabella when both the eyes close. It is exaggerated and persistent in parkinsonism.

VII cranial nerve

Anatomy

The nucleus of VII cranial nerve is situated in the pons lateral to the VI cranial nerve nucleus, around which its fibers wind before emerging on the outer aspect of pons (Fig. 5.15). The nerve courses along with the VIII cranial nerve to the internal auditory meatus, enters auditory canal and gives off a branch to stapedius muscle. It emerges from mastoid foramen at the anterior border of mastoid process, innervates facial muscles (except levator palpebrae superioris), scalp muscles and the platysma.

Taste fibers from anterior two-thirds of the tongue leave the lingual nerve to join chorda tympani, which joins the facial nerve in the auditory canal. Taste fibers pass through the geniculate ganglion and nervus intermedius to enter medulla oblongata. Facial nerve has a small somatic afferent component that innervates the auricle. The upper part of face has bilateral cortical representation (Fig. 5.16). Hence, it is not paralyzed in unilateral UMN lesions.

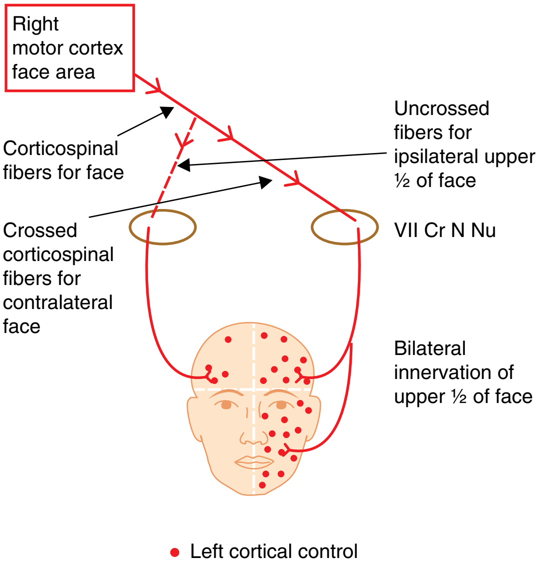

Right motor cortex face area
Corticospinal fibers for face
Uncrossed fibers for ipsilateral upper ½ of face
Crossed corticospinal fibers for contralateral face
VII Cr N Nu
Bilateral innervation of upper ½ of face
● Left cortical control

Figure 5.16 Upper motor neuron innervation of face.

Examination of facial nerve

With facial paralysis, there is loss of furrows of the forehead, flattening of nasolabial fold and drooping of angle of mouth with drooling of saliva. Food particles accumulate between the teeth and the cheek.

With chronic partial denervation, contractures may develop with pulling of the angle of mouth to the paralyzed side, giving an apparent impression of paralysis of the opposite (i.e. normal) side. Ask the patient to show his teeth when the mouth gets pulled to the healthy side. There may be hemifacial spasms. Long standing LMN lesion results in fascial muscle atrophy. Aberrant recovery results in crocodile tears.

Ask the patient

- To furrow his forehead and look upward. Compare furrowing of both the sides.
- To close eyes tightly. Weakness manifests as inability to close the eye, partial closure or weak closure. The eye lashes are not buried in the face, and the corner of the mouth is not drawn up or not as much as on the normal side. Confirm weakness by trying to open the tightly closed eyes. Normally, this is almost impossible. With attempted closure of the eye, the eye ball rolls up, the Bell's phenomenon, a normal occurrence.
- To whistle. With facial weakness this is not possible.
- To inflate the mouth with air and blow out the cheeks; tap the cheeks with a finger or press both the cheeks. Note air escaping easily from the weak side.
- Test the taste sensations of the anterior 2/3 of tongue.

Taste sensation

Taste sensation of anterior two-thirds of tongue is affected in lesions of VII cranial nerve.

Examination of taste sensation

- Anterior two-thirds and posterior one-third of each half of the tongue are examined separately
- Ask the patient to keep his tongue protruded throughout the examination
- Hold the tongue gently with a swab
- Wipe off saliva
- Apply strong solutions of sugar and salt, and weak solutions of citric acid and quinine sequentially in that order to the tongue with a swab and ask the patient to identify the taste. Wipe the tongue after each application.

Lacrimation

Lacrimation is tested with Schirmer's test. A blotting paper strip is placed under the lower canthus and observed for wetting in 5 minutes. Normal wetting is at least 10 mm. To confirm diminished lacrimation, repeat the test-after asking the patient to smell ammonia (stimulates lacrimation).

Involuntary facial movements

- Facial hemispasm
- Dystonia
- Tardive dyskinesia

Localization of facial nerve lesions (Table 5.1)

Table 5.1 **Localization of facial nerve lesions**

Site	Signs
1. Above nucleus (above pons)	Weakness of contralateral lower half of face (UMN paralysis) Weakness of opposite side (contralateral hemiplegia) Preservation of spontaneous movements, e.g. smiling, crying Absence of muscle wasting
2. Nuclear (pons)	Ipsilateral LMN facial paralysis Contralateral hemiplegia VI cranial nerve may also be involved
3. Cerebellopontine angle	Ipsilateral LMN facial paralysis + involvement of VIII cranial nerve and ophthalmic division of V cranial nerve
4. Facial canal (petrous temporal bone).	Ipsilateral LMN facial paralysis
• Proximal to chorda tympani	Loss of taste sensation of anterior two-thirds of tongue, salvation and lacrimation
• Proximal to nerve to stapedius	LMN facial paralysis with hyperacusis
• Geniculate ganglion	Ramsay Hunt syndrome (see page 167)
5. Parotid gland	LMN paralysis of facial muscles innervated by the affected branch(es) of facial nerve (upper, lower)

VIII cranial nerve

Anatomy

VIII Cranial nerve has a cochlear and a vestibular component. Former is concerned with hearing and the latter with equilibrium, balance and bodily displacement. Cochlear nerve innervates cochlea, and vestibular nerve innervates labyrinth and semicircular canals (Fig. 5.17).

Auditory nerve fibers arise from cochlear (spiral) ganglion situated in the central pillar of cochlea. Its peripheral nerve endings innervate the hair cells of the organ of Corti. The nerve emerges through the internal auditory meatus, traverses cerebellopontine angle, enters pons at its lower border and ends in dorsal and ventral cochlear nuclei. From here, auditory tracts decussate partially and ascend up to terminate in the inferior colliculi and medial geniculate bodies. The next relay of fibers passes through the internal capsule to first and second temporal gyri, the cortical auditory area. Though fibers from one side end predominantly in the opposite hemisphere, due to the partial decussation of auditory tracts, unilateral brain stem and cortical lesions do not produce unilateral deafness.

Vestibular fibers arise from vestibular ganglion, accompany auditory fibers and terminate in the vestibular nuclei situated in pons and medulla. Vestibular nuclei are connected with the cerebellum.

Symptoms

1. Tinnitus – It is persistent ringing in the ears. It is rarely neurogenic in origin.
2. Hyperacusis – It is due to paralysis of stapedius. Even mild sounds cause discomfort or pain.
3. Auditory hallucinations and delusions are more common in nonorganic psychosis, like schizophrenia.
4. Recruitment (an abnormal increase in the perception of loudness) occurs with sensorineural deafness due to cochlear damage.

Examination of auditory function

- Test each ear separately. Stand on the side of the ear to be tested and mask hearing from the opposite ear.
- First test whispering distance. Normal whispering distance is 10 feet.
- If the patient does not understand whispered words, test capacity to understand conversation. Normal conversation distance is 20 feet. Note the distance at which conversation is possible.

Both these are relatively crude tests.

Rinne's test

Normally, air conduction (AC) is better than bone conduction (BC). Place a vibrating tuning

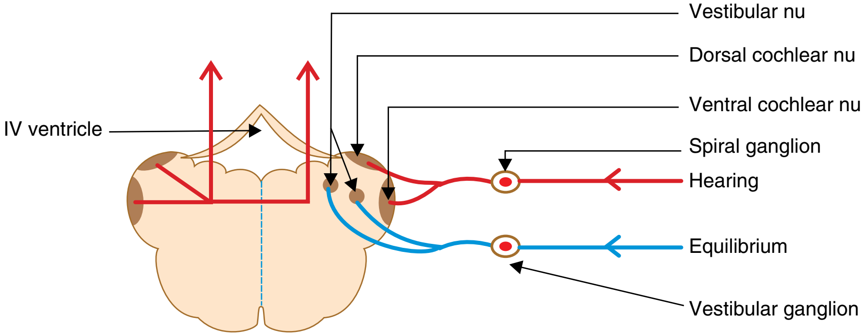


Figure 5.17 VIII cranial nerve.

fork 512 HZ on the mastoid bone. Ask the patient to tell or indicate as soon as the sound ceases. Immediately hold the tuning fork near the external auditory meatus and ask the patient if he can hear the vibration. If he can, Rinne's test is positive. In middle ear deafness BC > AC (Rinne's negative). In partial sensorineural deafness, AC > BC.

Weber's test

Use a tuning fork of 512-Hz frequency and place the vibrating tuning fork at the center of patient's forehead or the vertex.

- If the patient hears vibration at the point of application of the tuning fork, either there is no hearing loss or hearing is equally diminished in both the ears
- If the vibration is better heard on the normal hearing side, patient has sensorineural deafness
- If the vibrating sound is better heard on the side of diminished hearing, there is conductive deafness

Special tests

Pure tone audiometry – It quantifies hearing loss.

Examination of vestibular function

Vestibular symptoms

- Vertigo – It is hallucination of rotational movement of self or of the surroundings. It is present with acute peripheral (labyrinthine) lesions and with central pathologies.
- The patient may experience swaying, unsteadiness or dizziness. This should be differentiated from cerebellar and proprioceptive disorders.
- Oscillopsia is inability to stabilize an image on the retina.
- Gait – Patients with uncompensated vestibular pathology tend to veer to the affected side

Ramsay Hunt syndrome

- Severe ear pain
- Vesicular lesions over external auditory meatus (and pharynx)
- Lower motor neuron facial palsy (transient or permanent)
- Loss of taste (anterior two-thirds of tongue), salivation and lacrimation
- Hyperacusis
- Hearing loss (with variable recovery), vertigo and tinnitus (both transient)

IX, X, XI cranial nerves

Anatomy

Glossopharyngeal nerve mediates sensations (ordinary and taste sensations) from the posterior one-third of tongue. Motor fibers innervate middle pharyngeal sphincter and stylopharyngeal muscle. The nerve is rarely damaged alone. It is tested by checking taste sensation of posterior one-third of tongue (by using a galvanic current) and palatal reflex (which also tests vagus nerve).

The motor fibers of X cranial nerve originate from nucleus ambiguus. The nerve emerges from medulla, passes through the pharyngeal plexus and innervates muscles of palate, pharynx and larynx. Parasympathetic and visceromotor fibers arise in the dorsal nucleus situated at the floor of the 4th ventricle.

XI cranial nerve has a spinal and a cranial component (Fig. 5.18). The spinal part of the accessory arises from the lateral column of spinal cord, ascends up, enters the cranial cavity via foramen magnum, joins its cranial part and emerges through the jugular foramen. The two divisions then

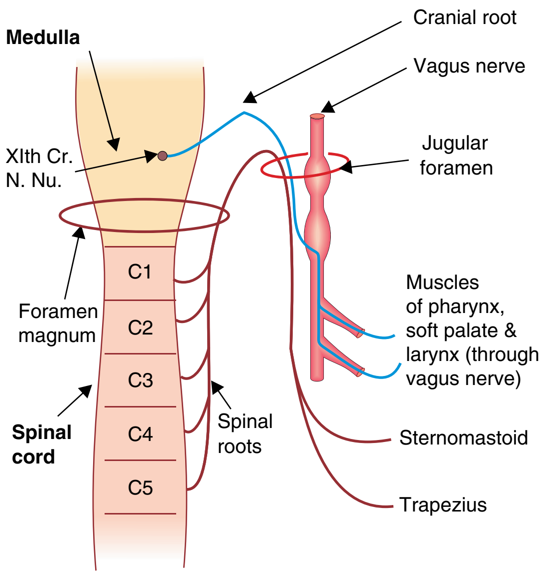


Figure 5.18 XI cranial nerve.

separate. The accessory (medullary) division joins vagus and supplies motor fibers to pharyngeal and laryngeal muscles. The spinal portion innervates sternomastoid and upper part of trapezius muscle.

Examination of IX and X cranial nerves

Symptoms and signs

1. Loss of ordinary and taste sensations from posterior one-third of the tongue
2. Nasal regurgitation of fluids while swallowing (suggests total palatal paralysis)
3. With UMN lesions, dysphagia is particularly to solids; with LMN lesions, it is particularly to fluids.
4. Ask the patient to pronounce egg, rub. In palatal palsy, these are pronounced as "eng" and "rum" (the voice has a nasal quality). Symptoms may not be apparent with unilateral palatal palsy.
5. For direct palatal examination, examine with the patient facing a bright light or use a light source. With mouth open, depress the tongue with a tongue depressor and note the position of uvula. Ask the patient to say "ah" and note palatal movement.
    a. Normally, both sides of the palate arch equally and uvula remains central
    b. With unilateral palatal palsy, the uvula is pulled up and towards the healthy side (mild transient asymmetry of palatal movement may be seen in acute UMN lesions)
    c. With bilateral paralysis, the palate remains immobile
6. Test gag reflex by tickling the posterior pharyngeal wall with a spatula and note reflex contraction of pharynx. With unilateral lesion, the reflex cannot be elicited on the affected side (palsies of IX and X cranial nerves). In pseudobulbar palsy, the reflex is exaggerated.

Examination of accessory nerve

- Lesions of accessory nerve lead to paralysis of sternomastoid and upper part of trapezius muscle.
- Ask the patient to shrug shoulders against resistance and assess muscle strength (trapezius).
- To test sternomastoid muscle, ask the patient to turn his chin against resistance to the opposite side and note the muscle strength. Additionally there may be
- Atrophy of sternomastoid muscle with less prominence on contraction
- On resisted flexion of the neck, the chin deviates to the affected side due to unopposed action of opposite sternomastoid

Other features are

- Drooping of shoulder on the affected side
- Rotation of scapula with the lower angle nearer to the midline

Accessory nerve may be involved in –

- Bony anomalies at the base of skull
- Syringomyelia
- Trauma
- Polymyelitis.
- Tumors at jugular foramen
- Motor neuron disease (MND)
- Spinal muscular atrophy
- Polyneuropathy

XII cranial nerve

Anatomy

The nucleus of XII cranial nerve is situated in the lower part of floor of 4th ventricle near the midline. The nerve courses forward and emerges on the anterior aspect of medulla between the anterior pyramid and the olive. It innervates muscles of tongue and depressors of hyoid bone (Fig. 5.19).

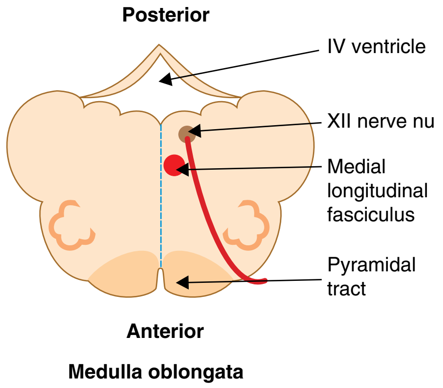


Figure 5.19 XII cranial nerve.

Examination

Ask the patient to open his mouth and examine the tongue as it lies at the floor of the mouth.

- In unilateral paralysis, there is atrophy of affected half of tongue and the tongue is curled towards the affected side.
- With bilateral LMN lesion, the tongue lies shriveled at the floor of mouth.
- With active degeneration (e.g. MND), fasciculations are present in the tongue resting at the floor of mouth.
- Ask the patient to protrude tongue straight forward, as much as possible. With unilateral paralysis, tongue deviates towards the paralyzed side.
- Ask the patient to move his tongue from side to side and touch each cheek. Strength can be assessed by a finger pressed against the cheek as the tongue pushes against it.
- Tremor of tongue is present in Parkinson's disease, both with the tongue at rest and when protruded out.

Note – With unilateral facial paralysis, the tongue may spuriously appear to deviate to one side (transient abnormality).

Summary of cranial nerve examination

Box 5.4

- I – Test smell – Test each nostril separately
- II – Check visual acuity, visual fields, fundus and pupillary light response in each eye
- III, IV and VI – Test external eye movements, pupils and check for nystagmus
- V – Examine motor and sensory part, jaw jerk and corneal reflex
- VII – Test facial muscles, buccinator and taste sensation over anterior two-thirds of the tongue
- VIII – Check acuity of hearing and perform Rinne's and Weber's tests if hearing is diminished
- IX – Examine sensation in the tonsillar fossa
- X – Examine palatal movement and gag reflex
- XI – Test sternomastoid and upper half of trapezius
- XII – Examine tongue – Movements, appearance and fasciculations

THE MOTOR SYSTEM

The motor system has two components: the upper motor neuron and the lower motor neuron.

Upper motor neuron

Anatomy

The term *UMN* includes motor cortex and corticospinal tracts (pyramidal tracts) which terminate on motor cranial nerve nuclei in the brain stem and the anterior horn cells (AHC) in the spinal cord (Fig. 5.20). Apart from the fibers arising from motor cortex, the corticospinal tracts carry fibers arising from postcentral gyrus and subcortical structures. In the motor cortex, movements and not the individual muscles are represented. Therefore, UMN lesions are characterized by paralysis of movements and not of individual muscles.

Representation of body parts in the motor cortex is shown in Fig. 5.21. Parts concerned with skilled movements (e.g. tongue, fingers, thumb) have a wider area of representation. Lip, face and hand areas lie close to each other. Hence, in a cortical lesion, hand and face are affected together. Since the motor cortex is spread over a large area, focal lesions (vascular, space occupying lesions [SOLs]) involve only a part of motor cortex. Hence, total hemiplegia is not a feature of cortical lesions.

From cortex, corticospinal fibers descend down the corona radiata to internal capsule and occupy anterior two-thirds of the posterior limb of internal capsule (Fig. 5.22). Here, the fibers are closely packed, and even a small lesion causes complete

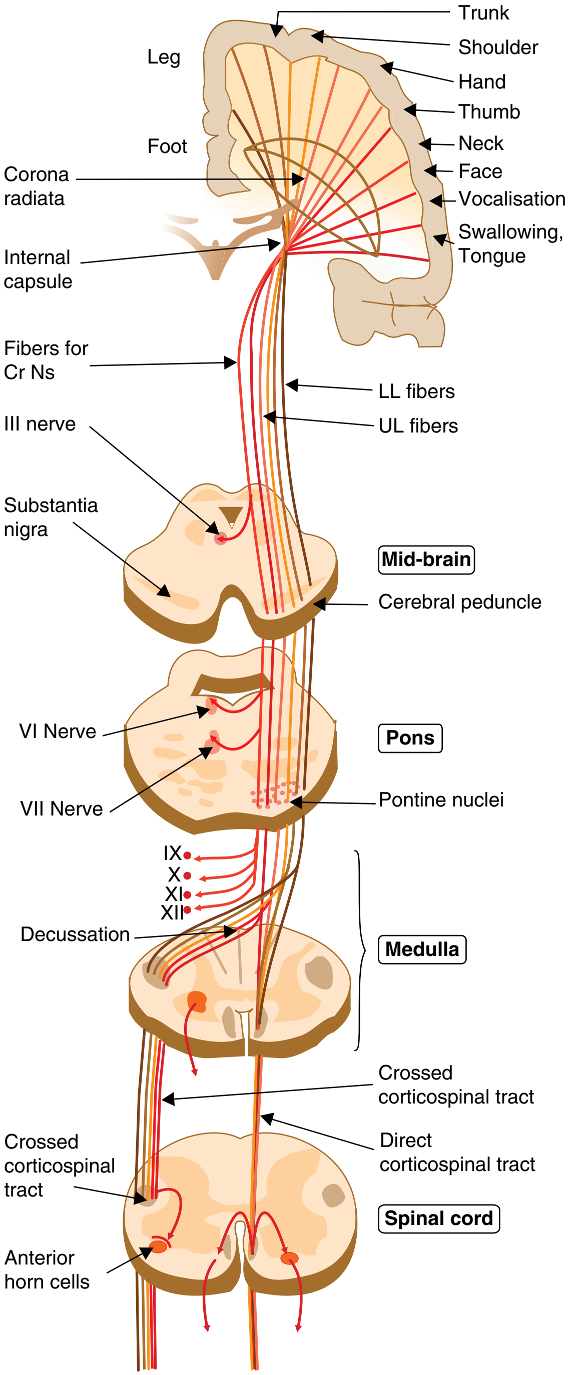

Trunk
Shoulder
Leg
Hand
Thumb
Foot
Neck
Face
Corona radiata
Vocalisation
Swallowing, Tongue
Internal capsule
Fibers for Cr Ns
LL fibers
UL fibers
III nerve
Substantia nigra
Mid-brain
Cerebral peduncle
VI Nerve
Pons
VII Nerve
Pontine nuclei
IX
X
XI
XII
Decussation
Medulla
Crossed corticospinal tract
Direct corticospinal tract
Crossed corticospinal tract
Spinal cord
Anterior horn cells

Figure 5.20 Corticospinal tracts.

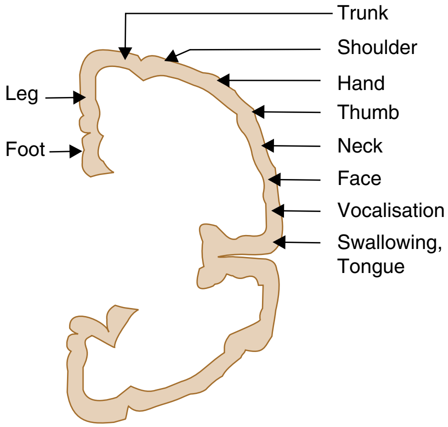

Trunk
Shoulder
Hand
Leg
Thumb
Foot
Neck
Face
Vocalisation
Swallowing, Tongue

Figure 5.21 Body representation in cerebral cortex.

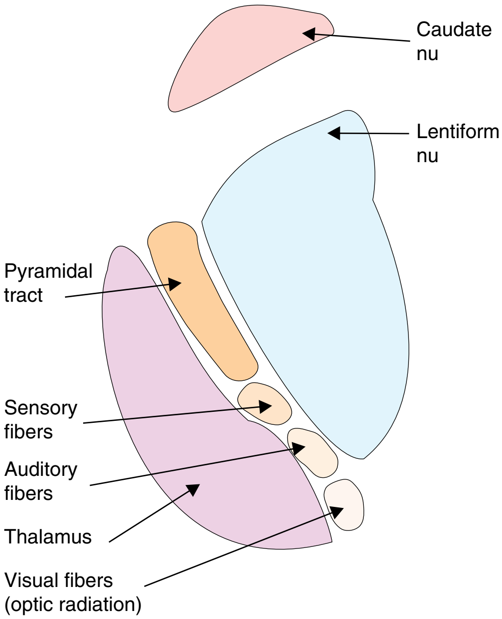

Caudate nu
Lentiform nu
Pyramidal tract
Sensory fibers
Auditory fibers
Thalamus
Visual fibers (optic radiation)

Figure 5.22 Internal capsule shows positions of pyramidal, sensory, auditory and visual tracts.

hemiplegia. Fibers then pass through cerebral peduncle occupying its middle two-thirds to enter the brain stem. Further down, the fibers occupy the bulb of pons. Here, the fibers are broken into bundles by the pontine nuclei and transverse pontine fibers. Descending down further, the fibers occupy the anterior part of upper medulla (pyramids). In the lower medulla, most of the fibers decussate with the fibers of the opposite side, occupy a lateral position and enter the spinal cord as crossed corticospinal tracts (the few uncrossed fibers, which continue ipsilaterally in the spinal cord, are of little clinical importance). Thus, the motor cortex of one side controls movements of opposite half of the body.

In the brain stem, fibers for the cranial nerves cross to the opposite side before terminating on the cranial nerve nuclei. In the spinal cord, the fibers end on anterior horn cells (AHCs).

Depending upon the location of the lesion, characteristic neurodeficits result (Table 5.2).

Table 5.2 **Clinical features of lesions of corticospinal fibers at different levels**

Site of the lesion	Clinical features
Motor cortex	Paralysis of a part of opposite side of the body, e.g. upper limb, lower limb (fractionate hemiplegia)
Internal capsule	Paralysis of the opposite half of body including face
Midbrain	*Ipsilateral palsy of III cranial nerve with contralateral hemiplegia including face (Weber's syndrome)
Pons	*Ipsilateral paralysis of VII cranial nerve with contralateral hemiplegia without facial involvement (Millard–Gubler syndrome)
Medulla	*Ipsilateral paralysis of XII cranial nerve with opposite side hemiplegia without involvement of face
Spinal cord	Ipsilateral LMN paralysis at the level of the lesion and UMN paralysis below the lesion

*Crossed hemiplegia.

Lower motor neuron

Lower motor neurons consist of nuclei of motor cranial nerves, AHCs, the nerves and motor synapses. LMNs are controlled by UMN and other descending fiber systems. Peripheral nerves are often combined sensorimotor nerves when sensory disturbances are present along with motor deficit.

Examination of the motor system

Examination of the motor system includes nutrition (muscle mass), muscle tone, muscle strength, coordination, involuntary movements, reflexes and gait.

Muscle mass

Muscle mass (or nutrition) is assessed by inspecting and palpating the muscles. Wasted muscles are smaller in size (bulk) and flabby in consistency unless fibrosis and contractures have developed. Muscle mass may be increased (hypertrophy) or decreased. Hypertrophy may be physiological or pathological as seen in muscular dystrophies.

Muscle wasting may be neurogenic (LMN lesion) or secondary to disuse (e.g. quadriceps wasting secondary to knee arthritis).

For keeping records and accuracy, with localized muscle wasting, circumference of the limb should be measured and compared with that of the opposite limb measured at the same level (usually midmuscle mass). Usual points of measurement (in adults) are 10 cm above or below olecranon tip, 18 cm above or below patella or adductor tubercle and 10 cm below tibial tuberosity. The pattern of muscle wasting can be diagnostic, e.g. in neuropathies and muscular dystrophies.

Tone

Examine muscle tone, with the patient relaxed. Hold the limb on either side of the joint and passively move the joint through the full range of movement and note the resistance. Compare tone on both sides. Note distribution of tone (flexors, extensors, adductors, abductors).

Abnormalities of muscle tone

- Hypotonia – Mild hypotonia may be difficult to appreciate in a fully relaxed patient. Marked hypotonia (flaccidity) is a feature of LMN lesion. Cerebellar dysfunction can cause hypotonia. Acute cerebral or spinal insults (trauma, stroke) are characterized by marked hypotonia due to neurogenic shock.
- Spasticity – Spasticity is a feature of UMN dysfunction. To appreciate spasticity, perform quick passive movements of the joint. Spasticity is felt as increasing resistance at the beginning followed by sudden give way (clasp-knife spasticity). Severe spasticity may prevent full range of movement. Sometimes, resistance is felt toward the end of movement. Severe and persistent spasticity can result in contractures.
- Rigidity – Rigidity is felt as continuous resistance throughout the range of movement. Rigidity is seen with extrapyramidal disorders, e.g. Parkinson's disease. In the absence of associated tremors, it is felt and described as lead-pipe rigidity; with superimposition of

tremors, it assumes a cogwheel character. It is best appreciated at the wrists by slow rotating movements and in the forearm with slow pronation and supination.

- Hysterical rigidity is characterized by resistance proportional to the force applied to passive movements.
- Differences between spasticity and rigidity are shown in Table 5.3.

Table 5.3 Differences between spasticity and rigidity

	Spasticity	Rigidity
Lesion	Upper motor neuron	Extrapyramidal
Tone	Increased in antigravity group of muscles	Increased in all muscles
Nature of increased tone	Clasp knife	Lead pipe or cogwheel
Power	Reduced	Normal
Deep tendon reflexes	Exaggerated	Normal
Plantar reflex	Extensor	Flexor
Clonus	Sustained	Absent

Muscle strength

Muscle strength is graded on 0–5 scale (Medical Research Council Scale)
Grade 0 – No visible muscle contraction
Grade I – Muscle flicker/contraction without movement
Grade II – Movement of joint with gravity eliminated
Grade III* – Movement against gravity but not against resistance offered by the examiner
Grade IV* – Movement against resistance but weaker than normal
Grade V – Normal power
*Compared to examiner's strength or based on expected muscle strength and experience

Terms used to describe muscle weakness are

- Paresis – Partial paralysis
- Plegia – Total paralysis
- Monoplegia – Paralysis of one extremity
- Hemiplegia – Paralysis of upper and lower extremity on one side of the body
- Paraplegia – Paralysis of both lower limbs
- Quadriplegia – Paralysis of all the four limbs

The following groups of muscles are tested:

Upper limbs

- Shoulder – Flexors, extensors, adductors, abductors
- Elbow – Flexors, extensors
- Wrist – Flexors, extensors
- Fingers – Flexors, extensors, adductors, abductors
- Thumb – Flexors, opponens, abduction

Lower limbs

- Hip – Flexors, extensors, adductors, abductors
- Knee – Flexors, extensors,
- Ankle – Dorsiflexors, plantar flexors, evertors, invertors
- Great toe – Dorsiflexors, plantar flexors

A minimal examination to exclude muscle weakness (when none is complained of or suspected) should consist of testing shoulder abductors, pinch (opponens), hip abductors and dorsiflexors of great toe.

Muscle power can be tested for isometric or isotonic strength. For isometric testing, ask the patient to maintain position against attempts to displace the limb. For isotonic testing, ask the patient to perform movement against resistance.

Testing of individual muscles

- Abductor pollicis brevis (C8–T1, median nerve) – Ask the patient to abduct his thumb at right angles to the palmar surface of the index finger against resistance. The contracted muscle can be seen and felt. Note the bulk of the muscle.
- Opponens pollicis (C6–C7, median nerve) – Ask the patient to touch the tip of his little finger with the tip of his thumb against resistance.
- First dorsal interosseous (C8, ulnar nerve) – Ask the patient to abduct his index finger against resistance.
  To test interosis and lumbricals (C8–T1 – ulnar N), ask the patient to flex the extended fingers at metacarpophalangeal joints (MCP).
  To test dorsal interossei, ask the patient to abduct the fingers against resistance.
  To test palmar interossei, ask the patient to grip a piece of paper with adducted fingers.
- Claw hand, characterized by overextension at MCP with flexion at proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints, is seen when interossei are paralyzed but not when the long flexors and extensors of fingers are paralyzed.

- Finger flexors (C8, median nerve) – Ask the patient to squeeze your middle and index finger and note the grip strength. Flexors of fingers can be tested individually by testing flexion at respective PIP joints.
- Wrist extensors (C6–7, radial nerve) – Ask the patient to make a fist and try to forcibly flex it against resistance. Normally, it is almost impossible. Minimal weakness is best brought out by asking the patient to grasp firmly something in his hand. If there is weakness, there will be flexion at the wrist.
- Wrist flexors (C6, 7, median and ulnar nerve) – (1) Ask the patient to make a fist and flex it. Try to overcome the wrist flexion, which normally is not possible, (2) ask the patient to grasp your two fingers and note the grip strength. (Note – Hand grip is weak with any pathology, neurogenic or musculoskeletal, involving wrist and fingers.)
- Brachioradialis (C5–C6, radial nerve) – With the forearm in midprone position, ask the patient to flex his elbow against resistance and note the strength. The contracted muscle can be seen in upper forearm.
- Biceps (C5–6, musculocutaneous nerve) – With the forearm in fully supine position, ask the patient to flex elbow against resistance. Note muscle strength. The contracted muscle can be seen.
- Triceps (C7, radial nerve) – Ask the patient to straighten forearm against resistance. Note the strength. The contracted muscle can be seen.
- Shoulder abductors – supraspinatus (C5), deltoid (C5) Ask the patient to abduct his arm against resistance. The first 30° of abduction is by the supraspinatus, while the remaining 60° is by the deltoid.

  Infraspinatus (C5) – Ask the patient to keep his elbow tucked into the side of his chest with the forearm flexed at 90° and rotate the limb outward against resistance, while maintaining the elbow by the side. The contracted infraspinatus muscle can be seen and felt.
- Pectoralis major (C6–8) – Ask the patient to stretch out his arms in front and try to clap the hands together against resistance. Note the strength. The contracted muscle can be seen and felt.
- Serratus anterior (C5–7) – When serratus anterior is paralyzed, there is winging of scapula (the vertebral border of the scapula projects posteriorly). If the patient is asked to push against resistance with his hands, the abnormality is brought out more clearly. Also patient is unable to raise his arm above 90°.
- Latissimus dorsi (C7) – (1) Ask the patient to clasp his hands behind his back, and resist the movement by standing behind the patient and note the muscle strength; (2) ask the patient to cough. The contracted muscle can be felt in the posterior axillary fold.
- Trapezius (accessory nerve) – Test the upper part by asking the patient to shrug his shoulders against resistance and the lower part by asking the patient to approximate the shoulder blades.
- Abdominal muscles (intercostal nerves, above umbilicus T7–T9, below umbilicus T10–T12) – Ask the patient, while lying in supine position, to lift himself without support. The contraction of rectus abdominis can be seen and felt on both sides of the umbilicus. The central position of umbilicus is maintained.

  If a side or upper or lower portion of abdominal muscles is weak, the umbilicus is pulled away from the affected part. This helps to localize level of lesion in the spinal cord. The Beevor's sign is pulling upwards of umbilicus in the presence of paralysis of lower abdominal muscles.
- Inability of the patient to sit up in bed without help indicates severe weakness of abdominal muscles and hip flexors.
- Erector spinae and extensors of back (all spinal segments, posterior rami) – Ask the patient to lie prone in bed and lift his head from the bed and extend the neck and back. Muscle contraction can be seen.
- Diaphragm (C3–5, phrenic nerve) – Ask the patient to take a deep breath and count 1, 2, 3 slowly in a single breath. Most healthy individuals can count up to 20 and beyond. Respiratory disorders are an important cause of diminished single-breath count. With diaphragmatic weakness, the patient has difficulty in sniffing and may experience difficulty in breathing while lying supine. Ask the patient to cough and note the strength of diaphragmatic contraction by palpating the upper abdomen. With severe weakness, inspiratory indrawing of upper abdomen may be visible.
- Intrinsic muscles of foot (S1) – These are tested by noting abduction and adduction of toes, as for muscles of hand. Wasting of small muscles of foot leads to pes cavus deformity. Similar deformity is

seen in long-standing spastic paralysis. Affection of interossei leads to clawing of toes.

- Dorsiflexors of toes and feet (L4–5, anterior tibial nerve) – Ask the patient to elevate his foot against resistance.
- Plantar flexors of feet and toes (S1–2, medial popliteal nerve) – Ask patient to depress toes and foot against resistance.
- Invertors of foot (tibialis posterior, medial popliteal – L4) – Ask the patient to slightly plantar flex the foot and try to invert his foot against resistance.
- Evertors of foot (peronei, Musculocutaneous n. L5-S1) – Ask the patient to evert his foot against resistance.
- Extensors of knee (L3–4, femoral nerve)

  Note quadriceps bulk, with the knee flexed, ask the patient to straighten his leg against resistance. A normal individual should be able to do so
  - ❑ Ask the patient to stand up from a low chair or stool
  - ❑ Ask patient to hop on either leg
- Flexors of knee (biceps femoris, semitendinosus and semimembranosus L4–5, S1–2, sciatic nerve) – With patient lying supine in bed, lift patient's leg with left hand and hold it at the ankle with the right hand. Ask the patient to bend his knee against resistance. A normal person should be able to do it.
- Extensors of hip (gluteus maximus, hamstrings L4,5 S1,2) – Lift patient's extended leg off the bed. Ask the patient to push it down against resistance.
- Flexors of hip (iliacus, psoas major, psoas minor, L1–L2) – (1) While lying supine in bed, with leg extended, ask the patient to lift his leg against resistance and (2) with the thigh flexed at right angle, test flexion at the hip.
- Adductors of thigh (L2–3) – Abduct patient's leg and ask the patient to adduct it against resistance.
- Abductors of thigh (L2–3) – Ask the patient to keep legs together and then try to separate them against resistance.
- Rotators of thigh – Ask the patient to roll his leg outward or inward against resistance with the knee held in extension.
- Flexors of neck (C1–C6 + accessory nerve) – Ask the patient to flex his neck against resistance.
- Neck rotators – Test sternomastoid (refer cranial nerve examination)
- Extensors of neck (C2–3) – Ask the patient to extend his neck against resistance.
- Lateral bending of neck (C2–3) – Ask the patient to bend his neck laterally against resistance.

Coordination

Coordination is the ability to perform complex movements smoothly and efficiently. It depends upon the integrity of sensory and cerebellar systems. Ataxia is lack of coordination.

The most commonly performed tests of coordination are finger-nose-finger test for upper limb and heel-knee test for lower limb.

- Finger-nose-finger test – Ask the patient to touch alternately with his index finger, tip of his nose and tip of his finger held at a comfortable distance. The test is first performed with eyes open and then with eyes closed. Incoordination with the eyes closed indicates sensory ataxia. If present even with eyes open, it indicates cerebellar ataxia (or very severe sensory ataxia).
- Heel-knee test (Heel-shin-ankle test) – Ask the patient, while lying supine in bed, to raise heel of one leg and place it on the opposite knee and slide it up and down the shin between knee and ankle. Inability to rest the heel on the knee correctly, irregular, jerky movements or sliding off of the shin indicate incoordination. The test is performed with eyes open. Lower limb coordination can also be tested by asking the patient to draw a large circle in the air with the toe. Normally, it is drawn smoothly. In cerebellar ataxia, it is irregularly squared off.
- Romberg's test – This tests integrity of position sense in the lower limbs. Ask the patient to stand with his feet as close together as possible (without losing balance) with his eyes open. Then ask the patient to close his eyes. With sensory ataxia, patient sways and may even fall unless supported. In normal individual, slight swaying may be present.

  Note – Proximal muscle weakness can mimic ataxia. Anxious patients may appear ataxic.
- Dysdiadochokinesis – Normally, one can perform alternating movements repeatedly, rapidly and smoothly. Inability to perform alternating movements is a sign of cerebellar dysfunction. The test is performed by asking the patient to carry out alternately pronation and supination of forearms with the elbows held at right angles or to tap palm of one hand with fingers of the other hand with alternate pronation and supination of forearm. (There may be slight difference in the

rapidity of movements between dominant and nondominant side.) In cerebellar disease, the movements are slow, awkward, jerky, irregular, often incomplete and cannot be performed for more than a few cycles. Performance of day-to-day activities (like buttoning of clothes) brings out incoordination.

Abnormal involuntary movements

Abnormal involuntary movements are unintended movements that may be present at rest or appear during voluntary movements or both.

- Fasciculations – These are spontaneous contractions of groups of muscle fibers in muscles undergoing neurogenic atrophy. Fasciculations are most commonly seen in MND. These can be brought on by light tapping of the muscles.
- Tremor – It is an oscillatory movement about one or more joints due to alternating contraction and relaxation of agonists and antagonists. A tremor can be slow or rapid; fine or coarse; present at rest, on maintaining posture, or during voluntary movements; and regular or irregular. The important features of tremors are tabulated (Table 5.4).
- Chorea – Chorea is characterized by rapid, involuntary, purposeless movements of the extremities, most pronounced distally. Choreic movements may be unilateral or bilateral. The movements are brief and can be superimposed on voluntary movements. There is hypotonia. Typically outstretched upper limbs when held above the head assume hyperpronated posture. Flickering movements of fingers, wrists, face and tongue may be present. Patient cannot keep his tongue protruded. It darts in and out. Emotions and voluntary movements worsen chorea. The movements disappear during sleep.
- Athetosis – These are slow, writhing, sinuous movements, consisting of alternating flexion and extension of fingers and wrists, often spreading proximally to involve the whole limb or even the whole body. The movements begin as widely extended fingers, followed by extension, abduction and external rotation of the arm, finger flexion (often clenching the thumb in the grip) and flexion and internal rotation of the extremity. In severe cases, fixed flexion and torsion deformity of the extremity may develop.

  Athetosis is present only if the limb is not fully paralyzed. It is a release phenomenon due to lesion in the extrapyramidal system (EPS) and its cortical connections. Upper motor neuron signs may not be always present. Athetotic movements are most commonly seen with infantile hemiplegia.

  Chorea and athetosis may occur together (choreoathetosis).
- Hemiballismus – Hemiballismus consists of swinging, ballistic and high-velocity (violent) movements of the limbs, with maximum amplitude at the shoulder and hip. There is

Table 5.4 Tremors and their clinical features

Tremor	Clinical features
• Anxiety tremor	Fine and rapid. Present at rest. May become coarse during voluntary movements. Similar tremor is seen with excess consumption of alcohol and coffee
• Thyrotoxic tremor	Fine and rapid. Best demonstrated with outstretched hands and a paper placed on extended fingers
• Essential tremor (benign tremor)	Often familial. Coarse and distal. May be reduced with voluntary movements. Head and neck nodding may be present
• Intention tremor	Seen in cerebellar disease. Present on voluntary movements, often maximum as the target is reached. Absent at rest
• Senile tremor	Similar to essential tremor. Seen in elderly
• Parkinsonian tremor	Coarse, rhythmic and alternating. May have a pill rolling character. Tongue, mouth and proximal parts involved with advancing disease. Early in the disease can be abolished by voluntary movements. Are worsened by attention. More prominent in upper extremity. May be unilateral.
• Flapping tremor	Seen with wrists fully extended and arms stretched in front. Present in hepatic, renal and respiratory failure (CO_2 narcosis)
• Hysterical tremor	Involves whole limb or body. Worsens with attempts to control or may spread to other parts of the body. Bizarre in appearance
• Clonus	Not a common involuntary movement. Spontaneous clonus is sometimes present with severe corticospinal dysfunction

hypotonia of the involved limb. The lesion is in the subthalamic nucleus, usually an infarct. It is a self-limited condition and resolves in 6–8 weeks.

- Dyskinesia – The term *dyskinesia* is applied to involuntary movements, affecting mainly the pharyngeal and facial perioral muscles. These are induced by phenothiazine group of drugs.
- Dystonia – Dystonia is an abnormally maintained posture. There is associated plastic rigidity of the involved muscles. Dystonia can be generalized, focal or segmental and primary or secondary. Writer's or typist's cramp is an example of occupational dystonia.
- Torticollis – Torticollis is a form of dystonia characterized by abducted and rotated posture of the neck. It can be spasmodic when it consists of jerky movements. It may sometimes be a precursor of generalized torsion dystonia.
- Tics and habit spasms – In contrast to chorea, these are repetitive, purposive movements. The same movements are repeated. Tics can be simple (eye blinking, shoulder shrugging) or complex involving many groups of muscles. Sometimes a verbal component accompanies these movements. Physical examination is normal.
- Myokymia – It is persistent twitching, most commonly affecting periorbital muscles. The movements tend to be rhythmic. Common causes are fatigue and anxiety. Myokymia may sometimes be due to the affection of facial nerve or its nucleus.
- Tetany – It is due to severe hypocalcemia or alkalosis. Hands are commonly affected. Fingers and thumb become stiff and go into an adducted posture. Sometimes, feet may also be affected similarly (carpopedal spasm). Tetany can be induced by inflating sphygmomanometer cuff 20 mm above arterial pressure and maintained for 2–3 minutes. The resultant ischemia induces tetany (Trousseau's sign). Chvostek's sign consists of transient twitching of facial muscles when facial nerve is lightly tapped with a percussion hammer below and in front of the ear. Trousseau's sign is also present in hypomagnesemia, hyperkalemia and hypokalemia.
- Cramps – These are most common in calf muscles. Cramps are common in healthy persons. Pathological causes include neurogenic muscle weakness (e.g. L5–S1 radiculopathy), MND, exhaustion, heat exhaustion, hyponatremia, hypomagnesemia and hypothyroidism.

Abnormal postures

Patient's posture is observed while lying in bed or standing. A variety of abnormal postures can be identified:

- Hemiplegia – Upper extremity is held adducted at the shoulder, flexed at the elbow, wrist and fingers, with the forearm pronated. In the lower limb, there is adduction at the hip, extension at the knee and plantar flexion, with sometimes inversion of the foot.
- Paraplegia in extension is seen with partially damaged spinal cord. Paraplegia in flexion is present with significant cord damage.
- Decerebrate and decorticate rigidity – These suggest severe bilateral hemispheric damage. Decorticate and decerebrate movements may be seen (in response to painful stimulus) in poisoned unconscious patients. However in these patients, these do not indicate irreversible damage.

Reflexes

There are three types of reflexes:

- Deep tendon reflexes (DTRs)
- Superficial or cutaneous reflexes
- Visceral or organic reflexes

Deep tendon reflexes

Deep tendon reflexes are documented as

- Clonus − ++++
- Exaggerated − +++
- Brisk/normal − ++
- Diminished − +
- Absent -
- Present on reinforcement +/−

Interpretation of DTRs

- Exaggerated DTR ± clonus – UMN lesion
- Brisk bilaterally in UL and LL – Anxious patient, tetanus
- Absent or elicited on reinforcement – Lesion of LMN or afferent pathway
- Apart from this, DTR may be absent in neurogenic shock, muscle diseases (myopathies), coma and the elderly (usually ankle reflex)
- Asymmetry of reflexes should be taken as abnormal if the asymmetry persists even with repeated testing

Other abnormalities of DTR

- Pendular jerk – It is seen in cerebellar disorders. There is to and from swinging movement of leg on elicitation of knee reflex
- Slow relaxation – It is seen in patients with hypothyroidism (hung up reflex)
- Inverted reflex – It is due to hyperexcitability of AHCs below the level of lesion in the spinal cord. Common examples are (1) inverted supinator reflex – when supinator tendon is struck with a percussion hammer, there is no contraction of brachioradialis, but finger flexion is observed (C5/C6 lesion) and (2) inverted biceps reflex – on testing biceps reflex, there is no contraction of biceps but there is contraction of triceps (C5/C6 lesion).
- Spread or radiation of DTR – When biceps or supinator reflex is elicited, not only do the biceps or the supinator contract but triceps also contracts or there is finger flexion. This is a manifestation of hyper-reflexia but is not pathognomonic of UMN lesion.

Localizing value of DTR **Box 5.5**

- Jaw jerk – Bilateral UMN lesion above pons
- Biceps – C5 (musculocutaneous nerve)
- Supinator – C5, C6 (radial nerve)
- Triceps – C7, (C8) (radial nerve)
- Finger flexion – C8 (median nerve)
- Knee – L3, L4 (femoral nerve)
- Ankle – S1 (medial popliteal nerve)

Elicitation of deep tendon reflexes

DTR is a monosynaptic response that involves an afferent and an efferent neuron. Deep tendon reflexes being segmental have localizing value. To elicit DTR, the patient should be comfortable and relaxed. Do not hit the tendon, but allow the weight of the hammer head to hit the tendon.

- Jaw reflex – Ask the patient to keep his mouth open, relax and let the lower jaw hang loosely. Place a finger on the lower jaw and strike it with a percussion hammer. It is barely elicitable in normal person.
- Biceps reflex – With the patient lying supine or sitting with elbow flexed at 90° and forearm in midprone position, place thumb on the biceps tendon and strike it with the percussion hammer. Contraction of biceps causes slight flexion and supination of the forearm.
- Supinator (radial) reflex – With the forearm in mid-prone position and the elbow flexed to 90°, strike the styloid process of radius with a percussion hammer. Brachioradialis contracts with flexion and supination of the elbow.
- Triceps reflex – Hold patient's arm at the wrist, flex elbow to 90° and strike the triceps tendon with a percussion hammer just above the tip of olecranon. Contraction of triceps results in extension of the elbow.
- Knee reflex – With the patient lying supine and knees flexed and supported with one hand or with the patient sitting at the edge of the bed and knees hanging loosely or with one leg crossed over the other and leg hanging loosely, strike patellar tendon sharply and observe contraction of quadriceps (extension of the knee or muscle contraction). In obese individuals, locate the patellar tendon first and then elicit the reflex.
- Ankle reflex – With the patient lying supine in bed, leg flexed at the knee and externally rotated at the hip, hold patients foot with one hand and dorsiflex it to stretch the tendoachilles tendon slightly (overstretching dampens the reflex) and strike it with a percussion hammer. There is plantar flexion of the foot or visible contraction of calf muscles.
- Hoffmann's sign – It is elicited by flexing the distal phalanx of the middle finger and releasing it abruptly. Increased tendon reflex activity of flexors of the fingers is seen as flexion of the thumb and fingers.
- Clonus – Clonus is the result of a series of sustained involuntary contraction of muscles that are initiated by sudden and sustained stretching of its tendon. Clonus is most commonly elicited at the ankle and knee (patellar clonus). Sustained clonus indicates UMN lesion.
- Ankle clonus – With the patient lying supine and knee flexed, support the back of his thigh and sharply dorsiflex patient's foot held in slightly everted position. In UMN lesion, this causes reflex plantar flexion. With continued pressure, alternating plantar and dorsiflexion movements continue as long as the pressure (stretch) is maintained.
- Patellar clonus – With the patient lying supine and leg fully extended at the knee, hold the patella in the angle between thumb and index

finger and push it down sharply. Clonus is seen as rhythmic contraction of quadriceps (patella moves up and down) till the stretch is applied.

Poorly sustained ankle clonus – There are a few cycles of flexion and extension, which can be stopped by increasing stretch on the tendon (seen in tense individuals). It has no pathological significance.

Superficial reflexes

These are plantar, abdominal and cremasteric reflexes. Abdominal and cremasteric reflexes are absent in lesions of UMN and segmental LMN lesions. Abdominal reflexes cannot be elicited with flabby abdominal wall.

Root values

Plantar reflex – L5, S1, S2
Abdominal reflex – T7–T12 (umbilicus T10)
Cremasteric reflex – L1

Superficial or cutaneous reflexes

The plantar reflex (L5, S1, S2); afferent and efferent (tibial nerve) is one of the most important signs in neurology. To test it, the patient should be relaxed (usually lying supine). Stroke/scratch firmly the outer border of sole of foot using a firm object such as a key (do not use sharp-pointed objects). The foot is stroked from heel towards the little toe along its outer border. (It is not necessary to stroke across the sole towards base of the great toe; else stop proximal to base of the great toe.) With increasing strength of the stimulus, following reactions are observed:

1. With light stroke – Contraction of fascia lata, ± adductors of thigh and sartorius muscle
2. Increasing stimulus – Flexion of 2nd–5th toes, followed by increasing flexion of all toes, and dorsiflexion and inversion of foot

Except with thick sole of foot, plantar response is never absent in normal healthy individuals.

The abnormal plantar response is known as (**Babinski**) extensor plantar response. It is pathognomonic of corticospinal lesion except in the new born till the age of 1–2 years (time taken for myelination of corticospinal fibers) and in coma or deep sleep. It is then present bilaterally. In extensor plantar response, the first movement is extension (dorsiflexion) of great toe, followed progressively by extension and fanning of other toes, dorsiflexion of ankle and flexion at knee and hip joints.

With severe lesions, the area from which the extensor response can be elicited widens and extends up the leg. This is the basis of the multiple signs described. Some of these are as follows (Fig. 5.23):

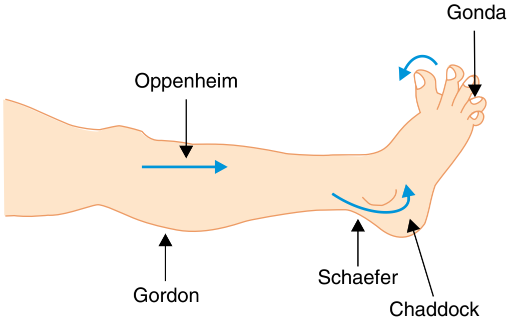


Figure 5.23 Other methods of eliciting extensor plantar response. Oppenheim (stroke along shin of tibia), Gordon (squeeze calf muscle), Schaefer (squeeze tendoachilles), Chaddock (stroke below lateral malleolus), and Gonda (push 4th toe down).

- **Oppenheim's sign** elicited by stroking firmly along the inner border of tibia
- **Gordon's sign** elicited by pinching the calf muscles
- **Schaefer's sign** elicited by pinching the tendoachilles
- **Chaddock's sign** elicited by scratching skin below the lateral malleolus
- **Gonda's sign** elicited by plantar flexion of the 4th toe and releasing it suddenly
- Glabellar reflex – Standing behind the patient, the glabella (area between the eyebrows) is tapped when the eyes blink. Normally, the blink response disappears after three to four taps. In parkinsonism, the response continues till elicited.
- Trapezius reflex – Place a finger over trapezius and tap it with a percussion hammer. There is slight elevation of shoulder. The reflex tests spinal accessory nerve (C1–2 segments).
- Anal reflex – Stroke the perianal skin gently. There is brisk contraction of external anal sphincter. The reflex tests pudendal nerve (S2–4 segments).
- Bulbocavernous reflex – On gentle pinching of glans penis, there is contraction of bulbocavernous muscle, detected by palpation at the root of scrotum. The reflex tests pudendal nerve (S2–4 segments).

Abdominal reflexes (upper abdomen T7–9, midabdomen T9–10, lower abdomen T11–12 and umbilicus T10)

Abdominal reflexes are elicited with the patient lying supine, and relaxed in bed, by stroking briskly

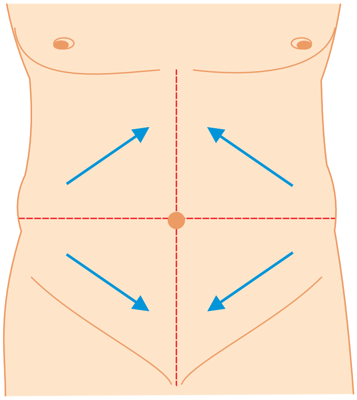


Figure 5.24 Elicitation of abdominal reflexes. Note direction of strokes (out→in) in the four quadrants.

but lightly the four quadrants of abdomen with a sharp object, on each side in turn. The stimulus is applied in the plane of the dermatome from outside towards the midline (Fig. 5.24). In a normal healthy individual, the reflex is a brisk contraction of abdominal muscles with pulling of the linea alba and umbilicus toward the stimulated quadrant. The reflex is usually brisker in upper quadrants than in lower quadrants. The most important pathological cause of absent abdominal reflexes is corticospinal lesion above the spinal level of the reflexes. Nonpathological causes are obesity and laxity of abdominal wall. The reflex is absent in neonates and it is difficult to elicit with flabby abdominal muscles. It fatigues easily and can disappear with repeated stimulation.

- Cremasteric reflex (L1–L2) – To elicit cremasteric reflex lightly stroke the inner side of the upper thigh (over the subsartorial canal) with the patient lying supine and thigh abducted and externally rotated. There is retraction of the testicle due to contraction of the cremasteric muscle. The reflex is easily elicited in children, but with difficulty in older men. The reflex is lost with UMN lesions.
- Corneal, conjunctival, pharyngeal and palatal reflexes are described under cranial nerves.

Posture

Abnormal posture depends upon type of dysfunction.
Upper motor neuron lesions

- Hemiplegia – (described earlier)
- Paraplegia – (described earlier)
- Lower motor neuron lesions – The posture depends upon the muscles affected. Initially, the posture (e.g. wrist drop, foot drop) is due to unopposed action of antagonists. Contractures cause irreversible postural abnormality.
- Extrapyramidal disorders – Parkinson's disease is characterized by mask-like face, stooped posture (flexed hips, knees, trunk and chin), upper limbs are held in flexion at the elbows and MCP joints with fingers and wrists extended. Shoulders are drooped.
- Sensory disorders – With loss of proprioception, patient stands with feet apart (wide base). Hypotonia may result in hyperextension at the knees.
- Cerebellar disorders – To maintain balance, patient stands with a wide base.

Gait

Examination of gait is important. Examine the gait with patient's clothes tucked above the knees. It is better if patient walks barefeet. First, ask the patient to walk freely in the room and then along a straight line. Note the following.

Can the patient walk without help? If he needs help, how much? Is the gait abnormal? Does he tend to fall? If so, to which side? Can he turn round quickly? If a gait disorder is observed, note its features and categorize the abnormality. It is important to exclude non-neurogenic causes such as painful knee or hip or a short lower limb. Various abnormal gaits are as follows:

- Spastic gait – It is a feature of UMN lesion. Because of the increased tone of antigravity muscles, patient has difficulty in flexing his knee and hip and dorsiflexing the foot during forward leg swing. To overcome this, the patient raises pelvis and then swings the leg forward in an arc (circumduction) dragging great toe along the floor. With severe cord lesion of corticospinal tracts, the gait assumes a scissors character (legs cross each other).
- Sensory ataxic gait – (stamping gait) – Here, the patient raises his leg more than usual, jerks it forward, brings the foot down to the floor with a stamp with the heel touching the floor first. Patient tries to overcome his difficulty in proprioception with the help of vision and therefore walks with eyes glued to the floor. Darkness aggravates ataxia (due to lack of visual compensation).

- Cerebellar ataxia – It resembles sensory ataxia. It is best described as a drunken or reeling gait. The patient walks with a wide base. Vision does not compensate for the lack of coordination.
- Festinant gait – It is typical of extrapyramidal disorders, e.g. Parkinson's disease. The body is bent forward. The gait is stiff. Patient walks with rapid, short steps (shuffles) giving an impression of a person trying to catch his center of gravity. Typically, if gently pushed forward, patient moves forward rapidly and finds it difficult to stop (propulsion); a similar difficulty is seen when pushed backward (retropulsion). Lateropulsion may be occasionally present. While walking, the arms do not swing. There is difficulty in turning round. Patient turns round in three to four short arcs.
- Bilateral deep white matter lesions of frontal lobe result in a similar (sticky) gait but the base is wide.
- Chorea and dystonia get exaggerated during walking.
- Waddling gait – It is seen with weakness of pelvic girdle muscles. There is lordosis of the lumbar spine and the base is wide. Body sways from side to side with each step. Trendelenburg sign is positive. Similar gait is seen with congenital dislocation of hips. Often, the patient stands up from lying position in a characteristic manner. He rolls on the face, brings hands and feet towards each other and then uses the upper limbs to 'climb up' the lower limbs with sideway and upward swinging of the arms and trunk at the end (**Gowers' maneuver**).
- Hysterical gait – It is bizarre and variable. Often, it is a poor attempt to mimic hemiplegic or ataxic gait. Unobserved, the gait is often normal. Other features of hysteria may be present.
- Limping – It is due to pain while walking. The patient carefully puts the painful foot forward, takes a short step and quickly transfers the weight to the normal limb.

Gait abnormality can be accentuated or brought out by asking the patient to walk heel to toe in a straight line (tandem walking). Abnormalities of gait are summarized in Box 5.6.

Abnormalities of gait

Box 5.6

Upper motor neuron lesion

- Hemiplegic gait – Unilateral UMN lesion
- Spastic (scissors) gait – Bilateral UMN lesion (usually in spinal cord)

Lower motor neuron lesion

- Foot drop – Peripheral neuropathy (peroneal nerve), L5–S1 root lesion, poliomyelitis
- Difficulty in negotiating steps (descending down); getting up from chair; buckling – Quadriceps weakness
- Waddling gait – Proximal muscle weakness

Disorders of cerebellum or its connections

- Cerebellar ataxic gait

Extrapyramidal disease

- Festinant gait – Parkinson's disease

Sensory disorders – Lesion anywhere along the sensory pathways

- Sensory ataxic gait

Upper motor neuron + posterior column lesion

- Spastic – ataxic gait

Hysteria

- Bizarre gait

Summary of patterns of motor abnormalities

Upper motor neuron.

- Spasticity
- Muscle weakness more in antigravity muscles than in muscles acting with gravity
- Absence of muscle wasting
- Exaggerated DTR
- Absent abdominal and cremasteric reflexes
- Extensor plantar response
- Sustained clonus

Lower motor neuron

- Hypotonia
- Muscle weakness
- Muscle wasting
- Fasciculations
- Absent DTR

Signs of cerebellar lesion

- Scanning staccato speech
- Nystagmus
- Absence of muscle wasting
- Disdiadokinesia
- Dysmetria
- Rebound phenomenon

- Hypotonia
- Normal muscle strength
- Ataxia
- Pastpointing
- Intention tremors
- Breaking of complex movements
- Pendular knee reflex

Peripheral neuropathy

- Lower motor neuron paralysis
  ±
- **Sensory abnormalities**

Primary muscle disease (myopathy)

- Symmetric proximal muscle weakness
- Pelvic girdle > shoulder girdle
- Muscle wasting (pseudohypertrophy in muscular dystrophies)
- Late loss of DTR
- No fasciculations

SENSORY SYSTEM

Anatomy and physiology

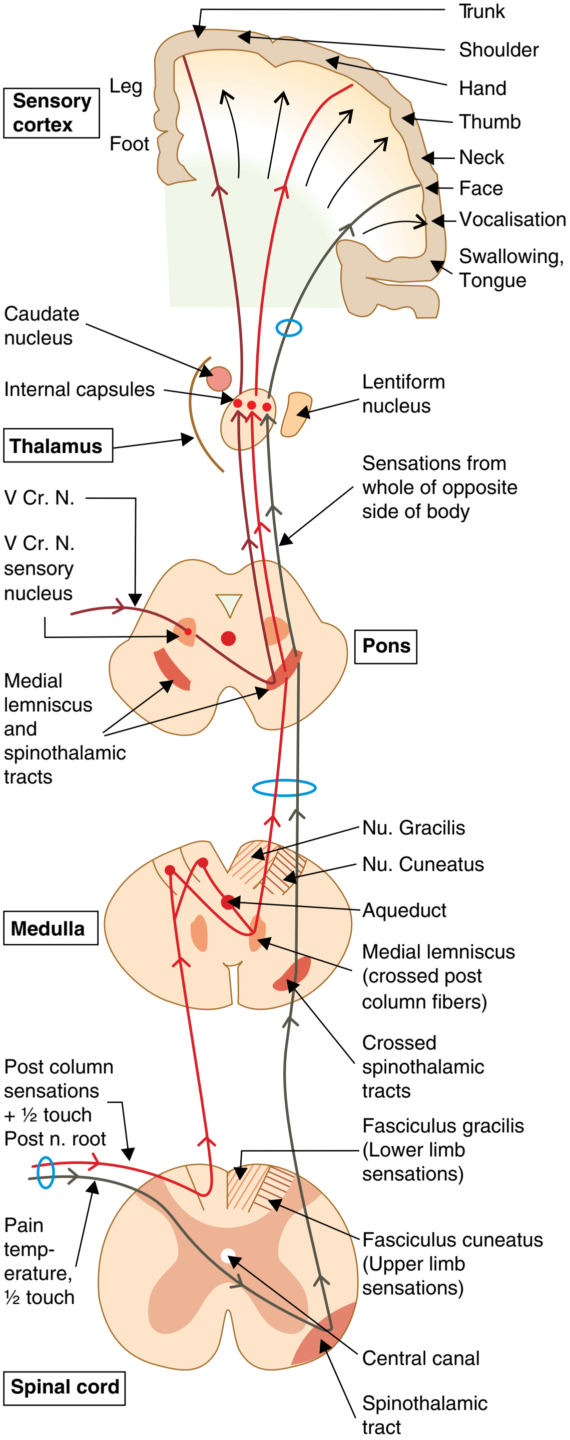

Trunk
Shoulder
Hand
Thumb
Neck
Face
Vocalisation
Swallowing, Tongue
Leg
Foot
Sensory cortex
Caudate nucleus
Internal capsules
Lentiform nucleus
Thalamus
Sensations from whole of opposite side of body
V Cr. N.
V Cr. N. sensory nucleus
Pons
Medial lemniscus and spinothalamic tracts
Nu. Gracilis
Nu. Cuneatus
Aqueduct
Medulla
Medial lemniscus (crossed post column fibers)
Crossed spinothalamic tracts
Post column sensations + ½ touch
Post n. root
Fasciculus gracilis (Lower limb sensations)
Pain temp-erature, ½ touch
Fasciculus cuneatus (Upper limb sensations)
Central canal
Spinal cord
Spinothalamic tract

Figure 5.25 Sensory pathways.

The sensations are broadly divided into cutaneous or superficial (touch, pain, temperature) and deep or proprioceptive sensations (joint position, joint movement, pressure and vibration). Sensory fibers travel along the peripheral nerves and enter the spinal cord via posterior root ganglia and posterior nerve roots. In the spinal cord, fibers carrying superficial sensations synapse with cells of spinal gray matter. A second relay of fibers crosses to the opposite side of the spinal cord, near the central canal (either at the same spinal level or a few segments above), to form anterior and lateral spinothalamic tracts (Fig. 5.25). The anterior spinothalamic tracts carry half touch, while lateral spinothalamic tracts carry pain and temperature sensations. The tracts ascend up the spinal cord and brain stem to end in thalamus.

The fibers carrying proprioceptive sensations, including part of touch sensation, ascend up the posterior columns on the same side of the spinal cord to end in nucleus gracilis and cuneatus just proximal to the junction of spinal cord with medulla. Because touch is carried by both spinothalamic tracts and posterior columns, with lesions of individual tracts, touch sensation is not totally lost. The arrangement of fibers carrying sensations differs in the spinothalamic and the posterior columns. While in spinothalamic tracts the fibers from lower part of the body occupy the outer part and those from upper part lie more medially, in the posterior columns, the arrangement is exactly reversed.

From the nuclei, a second relay of fibers crosses to the opposite side, ascends in the medial lemniscus and terminates in the thalamus. From here, all the sensations project to the posterior parietal cortex via internal capsule occupying the posterior limb of the capsule posterior to corticospinal tracts (Fig. 5.22). At the thalamic level, nociceptive sensations are recognized. These become excessive, unpleasant and prolonged in thalamic lesions. At the parietal cortex, complex sensations like stereognosis, localization and two-point discrimination are appreciated.

Sensory symptoms

Sensory symptoms can be positive or negative. Pins and needles, tingling, pricking, electric shock–like sensations, lightening or band-like sensations are positive symptoms. These are the result of lowered threshold of either peripheral or central components of the sensory system. Associated sensory loss may or may not be present.

Negative phenomena result from loss of function and manifest as diminished or absent sensations. There is demonstrable sensory loss. Loss of proprioception results in ataxia and inability to perform skilled or precision movements. The disability worsens on eye closure.

Some common terms of sensory symptoms are tabulated (Table 5.5).

Table 5.5 Common sensory symptoms

Symptom	Description
Paresthesia	Perception of abnormal sensations (such as tingling, pins and needles) without an apparent stimulus (persistent paresthesia suggest neurologic disorder)
Dysesthesia	Abnormal interpretation of bland stimuli – e.g. burning, pain
Hyperesthesia	Exaggerated perception of mild stimuli
Allodynia	Abnormal sensation, usually painful, to a normal stimulus
Hyperpathia*	Excessive response to pain
Causalgia	Burning, disagreeable sensation. Usually seen with neuritis
Hypesthesia	Diminished perception of specific sensory modality (e.g. pain, temperature, touch)
Anesthesia (analgesia)	Absence of perception of a sensory stimulus (e.g. touch, pinprick, temperature)

*Hyperpathia includes hyperesthesia, hyperalgesia and allodynia.

Sensory examination

Following sensations are tested routinely

- Light touch
- Pain (pinprick)
- Sense of joint position and movement
- Vibration

Deep pain, temperature and cortical sensations are tested when indicated.

Cutaneous sensations

Light touch – It is tested using a wisp of cotton wool, fine camel hair brush or with the tip of one's finger. Avoid stroking hair. Check if patient appreciates the touch and if yes whether the feel is normal or abnormal. Tips of fingers are most sensitive to light touch and localization.

- Superficial pain – It is tested using a sharp pin with a rounded head. Check that patient appreciates pinprick as pain and not just touch (by testing with sharp and blunt points of the pin). Compared to touch, sensitivity to pinprick is less at finger tips.
- Deep pain – It is tested by squeezing a muscle (usually calf muscle) or tendon (usually Achilles tendon). Note the pressure and the time required to appreciate deep pain. Deep pain is classically impaired in tabes dorsalis.
- Two-point discrimination – It is tested with a pair of blunt divider. Ask the patient if he perceives the touch as one point or as two points. The discriminating power is about 2 mm at the tip of fingers and 1 cm on pulp of toes and palm. It is widest on the back (few centimeters). Two-point discrimination is useful especially to test cortical function (lesions of parietal lobe), affection of posterior columns and peripheral nerve lesions that involve large afferent fibers, e.g. carpal tunnel syndrome.
- Temperature – Temperature sense is tested using test tubes containing hot (44 °C) and cold (30 °C) water. Touch the part to be tested with the side of the tube (and not the bottom) in a random fashion and ask the patient to identify the tube (warm or cold). Make sure patient recognizes hot and cold tubes by first testing on normal body part.

Proprioceptive sensations

- *Sense of joint position and movement*

First, explain the test to the patient. The patient should be relaxed and should keep his eyes closed. Sense of position and movement can be tested at any joint. Great toe and thumb are the most common sites. Hold the thumb or toe by its sides with the thumb and index finger and randomly move the joint a few degrees up or down and ask the patient to identify the new position. Movement of even a few degrees can be appreciated at all joints. Avoid contact with adjacent finger or toe or pulp of the finger or toe and ensure that the patient is not trying to move the joint. Sense of movement can be tested simultaneously.

In a patient with disturbed sense of position in the upper limbs, when the fingers are outstretched and eyes kept closed, pseudoathetotic movements are seen. These disappear on opening the eyes. Patients experience difficulty in performing simple skilled movements blindly such as fastening of buttons. There is ataxia. Romberg's test is positive (Box 5.7).

- Vibration sense is first tested at toes and ankles.

Place the stem of a 128 Hz vibrating tuning fork on a bony prominence. Ask the patient if he can feel vibration (not touch – it is a good idea to "test" nonaffected part such as forehead or sternum first for the patient to know what is being tested). If he feels the vibration, ask the patient to tell when the vibration stops. If at that point you can perceive vibration, patient's vibration sense is impaired. The test is important as it is often the first to be lost in diseases of peripheral nerves and posterior columns. With advancing age, vibration sense is impaired in feet and legs.

If vibration is affected at toes, test successively at proximal bony points – medial malleolus, tibial tubercle and anterior superior iliac spine. In upper limbs, the points are thumb, lower end of radius, olecranon and shoulder tip. On the trunk, it can be tested on spinous processes. This helps to demarcate the level of sensory loss.

Differences between sensory and cerebellar ataxia

Box 5.7

	Sensory ataxia	Cerebellar ataxia
▪ Hypotonia	Marked	Mild
▪ Wasting	±	Nil
▪ Loss of posterior column sensations	+	Nil
▪ Romberg's test	Positive	Negative
▪ Cerebellar signs	Nil	Present
▪ DTR	Absent	Present (pendular knee reflex)
▪ Gait	Stamping with eyes glued to the ground	Drunken

Parietal sensations

These can be tested only if there is no sensory loss.

- *Two-point discrimination is already described.*
- *Topognosis* (tactile localization) – With patients eyes closed, ask the patient to localize with his fingers the point touched.

- *Stereognosis*

Ask the patient to identify objects he is familiar with, that are easily identifiable and that are neither too large nor too small. Coins are most commonly used. Both sides should be tested separately. Perform the test with patient's eyes closed. Stereognosis is impaired or lost with parietal lobe lesions.

- *Graphesthesia*

If the patient is unable to hold objects, draw alphabets or numbers on the skin and ask the patient to identify the same. This is lost in affection of parietal lobe.

Similarly, patient's ability to identify texture of fabric is tested.

- *Barognosis*

Patient's ability to assess weight can be tested.

- *Tactile extinction/rivalry*

With patient's eyes closed, first test each side of the body separately to confirm that the patient can feel pinprick or touch. Then, deliver a stimulus simultaneously to both sides on identical points and ask the patient if one or both sides are stimulated. Patients with parietal lobe lesion can identify stimuli in isolation on both sides but fail to identify the stimulus on the affected side when both sides are tested simultaneously. For localization of lesion based on sensory abnormalities see Table 5.6.

Table 5.6 **Localization of lesions based on sensory abnormalities**

Sensory loss	Location of lesion
• Astereognosis	Opposite parietal cortex
• Hemianesthesia (loss of all sensory modalities)	Contralateral thalamus
• Hemianesthesia limited to proprioception	Contralateral thalamus (partial lesion); medial lemniscus in brain stem
• Contralateral loss of touch, pain, temperature with hyperalgesia and hyperesthesia	Contralateral thalamus (partial lesion)
• Loss of pain and temperature sensations of one side of face and opposite side of the body	Medulla involving ipsilateral descending tract of V cranial nerve and crossed ascending spinothalamic tracts (lateral medullary syndrome)
• Loss of all sensations below a level, with or without hyperalgesia just above the level	Spinal cord lesion involving all sensory pathways (transverse myelitis)
• Bilateral loss of pain and temperature sensations below a level with preservation of posterior column sensations	Bilateral involvement of anterior two-thirds of the cord (anterior spinal artery thrombosis)
• Loss of pain and temperature sensations of one half of body below a level with loss of posterior column sensations and UMN paralysis on the opposite side below the level of lesion	Involvement of one half of the cord (the side with loss of posterior column sensations) (Brown–Sequard syndrome)
• Suspended segmental loss of pain and temperature sensations	Crossing spinothalamic tracts – central cord lesion (syringomyelia)
• Dermatomal sensory loss	Dorsal nerve root
• Peripheral sensory loss (gloves and stocking)	Peripheral nerve
• Saddle anesthesia (all modalities) with loss of leg DTR and sphincter control	Cauda equina
• Sacral sparing of pinprick and temperature sensation	Intrinsic cord lesion

AUTONOMIC NERVOUS SYSTEM

Anatomy

Sympathetic and parasympathetic systems make up the autonomic nervous system (ANS). The sympathetic outflow extends from T1 to L2 spinal segments. The parasympathetic outflow is through cranial nerves III, VII, IX and sacral 2–4 spinal segments. Both the systems are under hypothalamic control.

Autonomic nervous system modulates functions of cardiovascular and gastrointestinal systems controls bladder and bowel sphincter activity and reflex mechanisms of respiration and pupils. It is also concerned with temperature regulation.

Clinical manifestations of autonomic dysfunction are

- Postural hypotension (orthostatic hypotension)
- Constipation, fecal incontinence
- Poor urine stream, retention or incontinence
- Impotence, erectile failure
- Esophageal and GI dysmotility
- Pupillary abnormality
- Impaired sweating
- Snoring and sleep apnea

Bedside examination of autonomic nervous system (ANS)

1. Orthostatic hypotension – With the patient lying quietly in bed or the couch, record blood pressure (BP) and pulse rate. Ask the patient to stand for at least 3 minutes and record BP and pulse rate. Normally, systolic BP drops by less than 10 mmHg and the pulse rate increases by less than 15 beats per minute. In the presence of autonomic failure, the drop is more than 30 mm Hg and pulse rate increases by more than 15 beats/minute.

2. Deep breaths test – Ask the patient to lie flat in bed. Allow pulse rate to stabilize and record it. Then, ask the patient to take six deep breaths and record pulse rate during that period. Normally, the difference between maximum and minimum pulse rate is more than 15 beats/minute. In autonomic dysfunction, the difference decrease is less than 10 beats/minute.
3. Handgrip – With the patient lying in bed, record BP. Ask the patient to grip sphygmomanometer cuff with maximal strength and note the pressure. Then, ask the patient to grip the cuff for 5 minutes at 30% of the pressure recorded. Normally, the diastolic BP increases by more than 16 mmHg. In autonomic dysfunction, the rise is less than 10 mmHg.
4. Valsalva test – Record patient's pulse rate. Ask the patient to blow into a sphygmomanometer and maintain a pressure of 40 mmHg for 15 seconds. Record the lowest pulse rate during the maneuver. Normally, the ratio of rest to Valsalva test pulse rate is more than 1.5. Less than 1.1 is abnormal.

Signs of meningeal irritation

Neck stiffness is increased resistance to passive flexion of the neck. To test neck stiffness, place a hand behind the occipital region and flex the neck to touch chin to the chest. With neck stiffness, apart from resistance, due to spasm of extensor muscles of neck, patient experiences pain, which may sometimes radiate down the back due to stretching of nerve roots. With marked stiffness, head is held in a retracted position

Causes of neck stiffness

- Meningeal irritation (meningitis, subarachnoid hemorrhage)
- Tetanus
- Cervical spine pathology
- Posterior fossa tumor
- Impending cerebellar herniation secondary to raised ICP
- Parkinsonism
- Lateral sinus thrombosis

Kernig's sign

With the patient's thigh fully flexed, extend the knee passively. In the presence of irritation of meninges of the lower part of the spinal subarachnoid space, this causes pain and hamstring spasm.

Brudzinski's sign

It has two components:

- When the patient's neck is flexed passively, in the presence of inflammatory exudate in the lumbar theca, there is flexion of hips and knees.
- Passive flexion of one leg produces flexion of the opposite leg.

Signs of nerve root entrapment

Nerve roots can be entrapped at the intervertebral foramina or compressed by a prolapsed disc. This causes spontaneous pain in the area of root distribution or it is brought on by stretching the root(s). The maneuver that reproduces pain is as follows:

Straight leg raising test (Lasegue's test)

Elevate the patient's extended leg passively with hand placed behind the heel. With L5–S1 root lesions, there is painful restriction of movement (usually between 30° and 70°). The pain radiates along the area of distribution of the nerve root. This is not a sign of meningeal irritation. It is due to stretching of nerve roots.

URINARY BLADDER

Anatomy and physiology

Urinary bladder has two components: the detrusor muscle and the internal sphincter. For effective emptying of bladder, coordinated contraction of detrusor and relaxation of internal sphincter are necessary. Opposite phenomenon allows bladder to relax and get filled with urine.

Micturition is a reflex act, but its initiation and inhibition are under voluntary control, the center for which is situated in the paracentral lobule of cerebral hemisphere. The higher control of initiation and inhibition depends upon the integrity of corticospinal tracts. At the local level, the reflex is mediated by bladder wall plexus and pelvic plexuses. These are innervated by the parasympathetic sacral outflow (S2–S4) via the hypogastric nerves and the sympathetic system through the pelvic nerves (T11–T12, L1–L2 segments of the spinal cord). Pudendal nerves (S2–S4) provide somatic innervation and also innervate the external sphincter (Fig. 5.26).

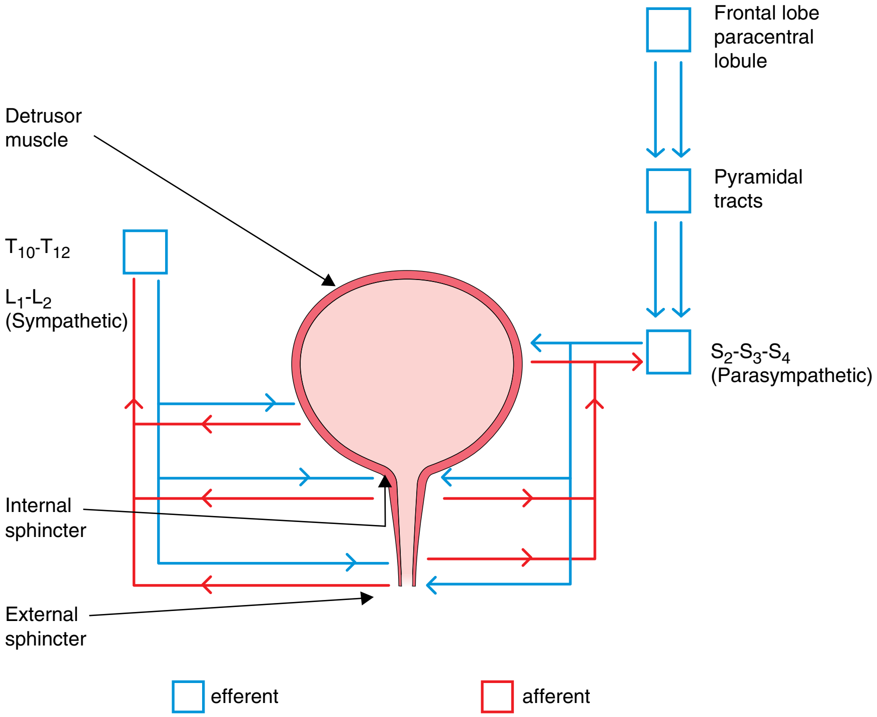


Figure 5.26 Neurogenic control of urinary bladder.

Neurogenic bladder

Neurogenic bladder can result from lesions at all the levels of its control. Some common causes are stroke, spinal cord injury, diabetes, alcohol, B12 deficiency, amyotrophic lateral sclerosis (ALS), parkinsonism, trauma, surgery and herniated disk. Other notable causes are multiple sclerosis and syphilis. Often, mechanical bladder neck obstruction, e.g. enlarged prostate, or stricture urethra aggravates the problem.

Neurogenic bladder can be flaccid due to peripheral nerve damage or damage to spinal cord at S2–4 level. Neurogenic shock secondary to acute cord lesion at higher level results in flaccid bladder temporarily. The bladder is large, with low pressure and absent contractions. There is urinary retention with dribbling overflow. Men have associated erectile dysfunction.

Spastic bladder is due to bilateral involvement of corticospinal fibers above T12 segment. The bladder is small, spastic (hypertonic) with involuntary contractions. Typically bladder contraction and external urinary sphincter relaxation are not coordinated. There is frequency, urgency and hesitancy of micturition with nocturia.

Neurogenic bladder is rarely if ever present in isolation. For evaluation of neurogenic bladder, urodynamic studies are employed.

Neurogenic bladder syndromes

- Acute transverse lesions of the spinal cord above T12 lead to retention of urine with distended bladder and overflow incontinence.
- Destruction of posterior nerve roots leads to atonic bladder with periodic incomplete emptying of bladder, which the patient is unaware of. Important causes are diabetes and tabes dorsalis.
- Cauda equina lesions (S2–S4), with destruction of afferent and efferent parasympathetic fibers, cause loss of bladder sensation and incomplete intermittent emptying of bladder.
- Bilateral, slowly progressive corticospinal involvement of the spinal cord (e.g. cord compression) is characterized by hesitancy and precipitancy of micturition.
- Bilateral frontal lobe affection manifests with inappropriate voiding of urine. There is loss of social control of bladder function. The bladder behaves like that of an infant.

Defecation

Lesions of cauda equina (sacral segment) result in loss of anal sphincter tone.

Lesions of conus medullaris result in loss of anal and rectal sensations.

Higher spinal cord lesions result in constipation due to sphincter contraction.

Sexual reflexes

The neurogenic pathways of penile erection and ejaculation are similar to those of bladder. Impotence often accompanies neurogenic bladder.

Mass reflex

This is seen in severe cord lesions. When a stimulus is applied to skin (below the level of the lesion), there is vigorous flexion of lower limbs, extension of great toe, sweating below the level of the lesion and sometimes bladder and bowel evacuation.

SPINAL CORD

Anatomy

Spinal cord extends from medulla to lower border of L1 vertebra. Vertebral levels do not correspond to spinal segments. For the cervical cord segment localization, add 1 to vertebral level, in upper thoracic add 2, in lower thoracic add 3 so that T9 vertebra corresponds to T12 cord segment. The lumbar and sacral segments form conus, which lies against L1 vertebral body. There are 8 cervical, 12 thoracic, 5 lumbar and 5 sacral segments. Cauda equina is formed by the lumbar and sacral nerve roots.

Structure of spinal cord is shown in Fig. 5.27.

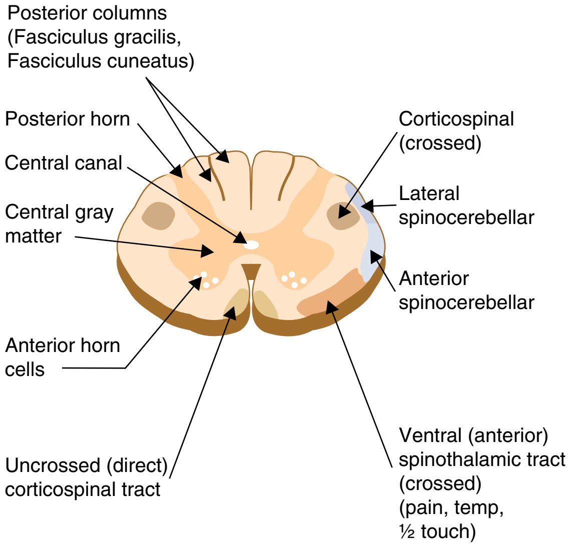

Posterior columns (Fasciculus gracilis, Fasciculus cuneatus)
Posterior horn
Central canal
Central gray matter
Anterior horn cells
Uncrossed (direct) corticospinal tract
Corticospinal (crossed)
Lateral spinocerebellar
Anterior spinocerebellar
Ventral (anterior) spinothalamic tract (crossed) (pain, temp, ½ touch)

Figure 5.27 Cross-section of spinal cord.

Blood supply

The anterior two-thirds of spinal cord is supplied by anterior spinal artery and the posterior one-third is supplied by posterior spinal artery. The spinal arteries are branches of the vertebral arteries and the aorta. One of the thoracic branch is large and is the main source of blood supply to the cord.

Clinical manifestations depend upon the level and extent of the lesion. These are described under cases.

CLINICAL CASES

Hemiplegia

Hemiplegia is paralysis of one half of body due to dysfunction of corticospinal tracts. The most common causes are cerebral infarction and hemorrhage. Infarction is usually secondary to thrombosis or embolism. Hemorrhagic and embolic strokes are sudden in onset and evolve rapidly. Thrombotic strokes characteristically progress in a stuttering fashion.

Other causes are trauma, subdural hematoma, meningitis, SOL (tumor, abscess, granuloma, cysts, secondaries) and postpartum venous sinus thrombosis. Demyelination and vasculitis are rarer causes.

Thrombotic stroke

1. History – Note
    a. Informant
    b. Handedness
    c. Onset, progression and present status
    d. Associated neuro symptoms (higher functions, cranial nerves, motor functions, sensory functions, bladder and bowel disturbances)

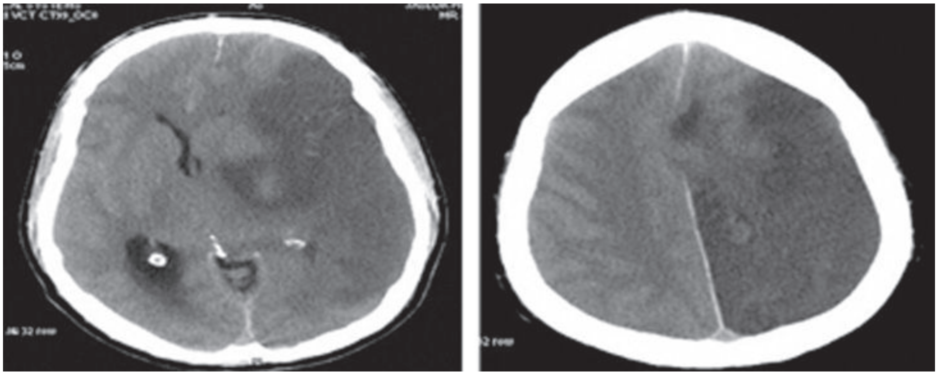


Figure 5.28 Computed tomography of brain – cerebral infarction. Hypodense area in the left cerebral hemisphere with midline shift.

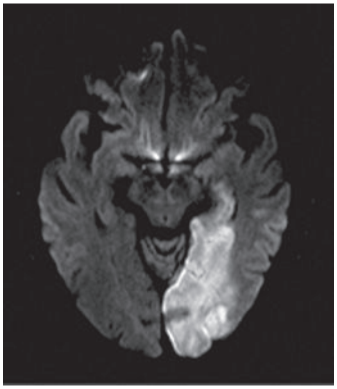


Figure 5.29 Magnetic resonance imaging of brain. Cerebral infarction seen as bright area.

   - **e.** Other symptoms (headache, vomiting, convulsions, preceding TIAs)
   - **f.** Treatment received and the response to treatment
   - **g.** Other illnesses (hypertension, ischemic heart disease, diabetes mellitus, peripheral vascular disease, valvular heart disease, infective endocarditis, tuberculosis, syphilis, antiphospholipid syndrome)
   - **h.** Medications, especially oral contraceptives

2. Physical examination
   - **a.** General examination – Specifically note the state of consciousness, neck stiffness, pulse, respiration, BP, carotids, peripheral pulses, bed sores and urinary catheter.
   - **b.** Complete neurology examination – Specifically note state of consciousness, speech, fundus, facial paralysis, involvement of other cranial nerves, stereognosis (if sensations normal), bladder and bowel function.
   - **c.** Examination of other systems, especially cardiovascular

     Physical findings vary with duration, and severity of paralysis, degree of recovery and the site of lesion.

3. Neurological findings
   - **a.** Acute stage (stage of neurogenic shock)
      - **i.** Consciousness variable (fully conscious to comatose)
      - **ii.** Conjugate deviation of eyes away from hemiplegic side (±)
      - **iii.** Ipsilateral UMN facial paralysis (same side as the hemiplegia)
      - **iv.** Hypotonic, areflexic, paralysis of upper and lower extremities
      - **v.** Extensor plantar response
      - **vi.** Hemisensory loss may be present on the affected side
      - **vii.** Urinary retention with coma or local obstructive uropathy

     The investigation of choice is computed tomography (CT) scan (Fig. 5.28) MRI scan is done when CT scan is not helpful (Fig. 5.29)
   - **b.** Partially recovered hemiplegia (stroke)
      - Higher functions usually normal (except sometimes residual motor aphasia)
      - Normal muscle mass
      - Spasticity
      - Variable muscle power, proximal > distal
      - Normal coordination (if muscle power ≥ Grade III)
      - No abnormal involuntary movements
      - Exaggerated DTR (+++/++++)
      - Extensor plantar response
      - Absent abdominal and cremasteric reflexes
      - Hemiplegic gait

Viva voce

Q1. What are the causes of transient hemiplegia?

- Transient ischemic attack
- Todd's paralysis
- Hypoglycemia
- Complicated migraine

Q2. What are the causes of cerebrovascular insufficiency?

- Atherosclerosis
- Infection
- Takayasu's arteritis and other large, medium and small vessel vasculitis
- Antiphospholipid antibody syndrome
- Dissection of aorta
- Fibromuscular dysplasia

Q3. What are the neurologic manifestations of carotid artery stenosis? (Fig. 5.30)

- Can be asymptomatic
- Headache
- Amaurosis fugax
- Transient ischemic attacks
- Stroke
- Focal convulsions

Q4. What are the clinical manifestations of lacunar infarction?

- Pure motor hemiparesis or monoparesis
- Clumsy hand syndrome
- Pure sensory stroke
- Ataxic hemiparesis
- Crossed hemiplegia
- Dementia, pseudobulbar palsy (multiple lacunar infarcts)

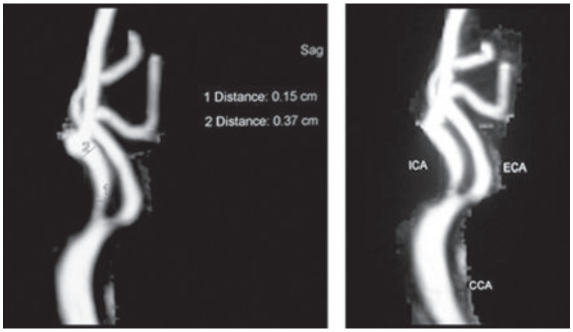


Figure 5.30 Contrast MR angio. Normal intracranial angiogram. Stenosis (50%) of extracranial internal carotid artery.

Q5. What is transient ischemic attack (TIA)?

- Transient ischemic attack is sudden focal neurodeficit lasting for less than 1 hour, mostly caused by emboli from carotid or vertebral arteries. Systemic hypotension can, on the background of pre-existing severe arterial stenosis cause TIA
- Symptoms resolve completely within few minutes
- Clinical manifestations are similar to those of ischemic stroke

Q6. What is the treatment of TIA?

- Endarterectomy with significant carotid stenosis (greater than 70%); results of stenting are unsatisfactory
- Antiplatelet drugs or anticoagulation

Q7. What are the common risk factors for ischemic stroke?

- Hypertension (most important cause)
- Smoking
- Diabetes mellitus
- Dyslipidemia
- Coronary artery and peripheral vascular disease
- Oral contraceptives
- Obesity

Q8. What is the prognosis of acute stroke?

- In hospital, mortality approximately 20%.
- Recovery is variable, usually incomplete. Earlier the onset of recovery, better the final outcome.
- Recurrences common, especially in the first year after the stroke.

Q9. How do you treat stroke?

- Care of unconscious patient: Adequate nutrition, and fluid intake (avoid overhydration), bowel and bladder care, prevention of decubitus ulcers. Control of BP if very high (systolic more than 220 mm Hg, or diastolic more than 120 mm Hg) but be careful not to reduce diastolic BP by more than 10–15%.
- For thrombotic stroke, seen within 3 hours, with no contraindications, thrombolysis or heparin.
- Decompression surgery is indicated with significantly raised ICP secondary to brain edema.

- Corticosteroids have no role.
- Physiotherapy

Q10. What are the contraindications to thrombolytic therapy?

- Intracerebral hemorrhage intracranial hemorrhage (ICH)
- Multilobar infarction
- Suspected subarachnoid hemorrhage
- Rapid deterioration
- Hypertension (systolic BP greater than 185 mm Hg, diastolic BP greater than 110 mm Hg)
- Recent surgery, head trauma, recent trauma, GI bleed (less than 3 weeks)
- Convulsions at onset
- Past history of intracranial hemorrhage
- Arteriovenous malformation, aneurysm or brain tumor

Q11. What are the poor prognostic signs of acute stroke?

- Altered mental state
- Old age
- Aphasia
- Brain stem signs

Q12. What are the causes of intracerebral hemorrhage?

- Hypertension (the most common cause)
- Ruptured aneurysm (congenital, mycotic)
- Vascular malformation
- Blood dyscrasias
- Collagen vascular diseases (systemic lupus erythematosus, vasculitis)
- Drug abuse (cocaine)
- Amyloid angiopathy

Q13. Enumerate important sites of intracerebral hemorrhage?

- Internal capsule
- Putamen (Fig. 5.31)
- Thalamus
- Cerebellum
- Brain stem

Q14. What are the causes of stroke in the young?

- Embolism secondary to atrial fibrillation, valvular heart disease, especially mitral stenosis with clot in left atrium, infective endocarditis
- Meningitis, encephalitis
- Tumor
- Hypertension
- Postictal
- Classical migraine
- Aneurysm, arterio-venous malformation (AVM), vasculitis
- Coagulopathy
- Multiple sclerosis
- Sickle cell disease
- Hysteria

Brain stem syndromes

These are vascular in origin. Depending upon the vessel involved, characteristic neurodeficits result. Broadly, these involve either medial one-third or lateral two-thirds of brain stem. Some of these are best known by eponyms.

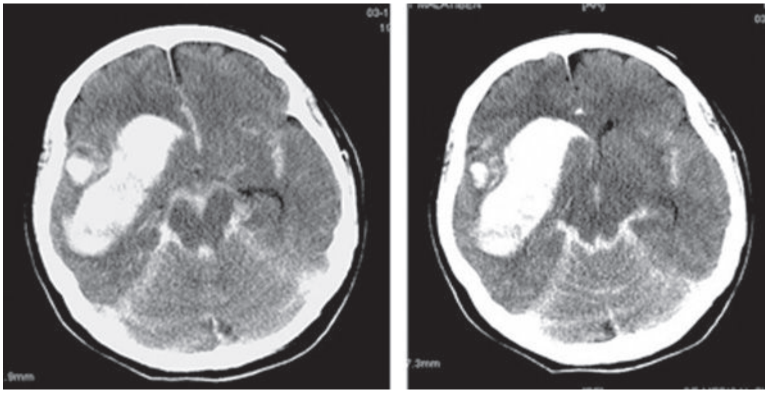


Figure 5.31 Computed tomography of brain – cerebral hemorrhage. Hyperdense area in right cerebral hemisphere involving basal ganglia.

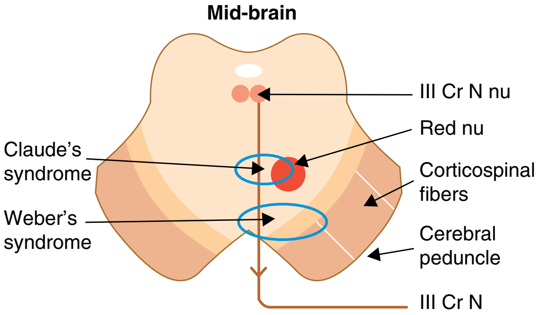

Mid-brain
III Cr N nu
Red nu
Claude's syndrome
Corticospinal fibers
Weber's syndrome
Cerebral peduncle
III Cr N

Figure 5.32 Weber's and Claude's syndromes.

Midbrain syndromes

Claude's syndrome (Fig. 5.32) – Ipsilateral palsy of III cranial nerve with contralateral cerebellar ataxia

Weber's syndrome (Fig. 5.32) – Ipsilateral palsy of III cranial nerve with contralateral hemiplegia

Pontine syndromes

Millard–Gubler syndrome – Ipsilateral facial paralysis with contralateral hemiplegia

Foville's syndrome – Ipsilateral palsy of VI and VII cranial nerves with contralateral hemiplegia

Medullary syndromes

- Medial medullary syndrome (Fig. 5.33A,B) – Ipsilateral palsy of XII cranial nerve with contralateral hemiplegia; impaired tactile and proprioception of opposite half of body.

Lateral medullary syndrome (Fig. 5.33A,B) – (due to infarction in the territory of posterior inferior cerebellar artery)

- Ipsilateral impaired pain and numbness over face (descending tract and nucleus of V cranial nerve)
- Dysphagia, hoarseness of voice, vocal cord paralysis, diminished gag reflex (IX and X cranial nerves)
- Vertigo, nausea, vomiting, nystagmus, diplopia, oscillopsia (vestibular nuclei)
- Loss of taste (nucleus and tractus solitarius)
- Hiccups
- Horner's syndrome (descending sympathetic tract)
- Ataxia of limbs and tendency to fall to the same side (cerebellum, olivocerebellar fibers, restiform body)
- Numbness of ipsilateral arm, trunk or leg (cuneate and gracile nuclei)
- Impaired pain and thermal sensations over contralateral half of body, sometimes including face

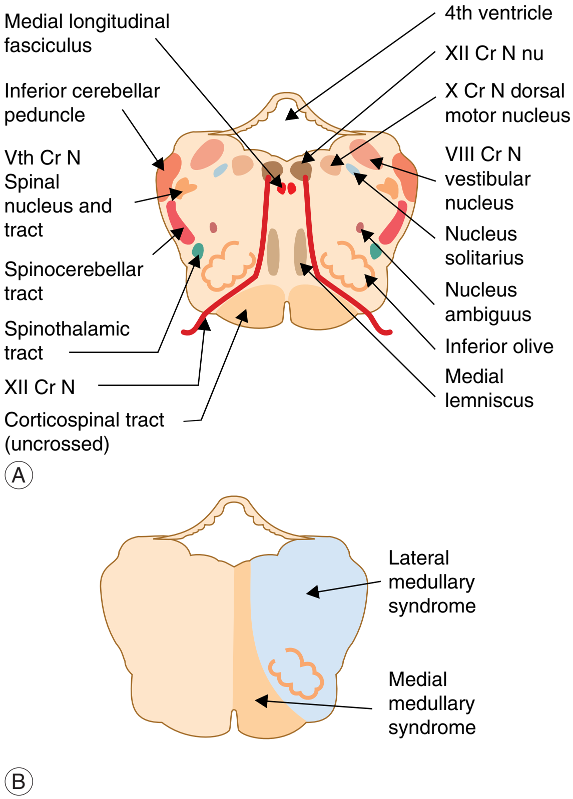

Medial longitudinal fasciculus
Inferior cerebellar peduncle
Vth Cr N Spinal nucleus and tract
Spinocerebellar tract
Spinothalamic tract
XII Cr N
Corticospinal tract (uncrossed)
4th ventricle
XII Cr N nu
X Cr N dorsal motor nucleus
VIII Cr N vestibular nucleus
Nucleus solitarius
Nucleus ambiguus
Inferior olive
Medial lemniscus
Ⓐ
Lateral medullary syndrome
Medial medullary syndrome
Ⓑ

Figure 5.33 (A) Cross-section of upper medulla. (B) Medullary syndromes.

Paraplegia

Paraplegia is weakness of both lower limbs. It can be neurogenic or non-neurogenic in origin. The paralysis may be of upper or LMN variety or combined. It may be associated with involvement of other components of the nervous system. This results in varied clinical patterns.

Causes

Cause of paraplegia can be central or peripheral. The three most common causes are trauma, tumor and tuberculosis. In majority of patients, paraplegia is due to spinal cord pathology.

Cerebral causes

- Cerebral diplegia
- Parasagittal meningioma
- Superior sagittal sinus thrombosis
- Unpaired anterior cerebral artery or bilateral anterior cerebral artery thrombosis (rare)

Spinal cord causes

1. Acute paraplegia
    a. Trauma
    b. Acute transverse myelitis
    c. Spinal epidural abscess
    d. Anterior spinal artery thrombosis
    e. Dissection of abdominal aorta
2. Subacute/chronic paraplegia
    a. Diseases of spine
        i. Tuberculosis
        ii. Cervical spondylosis
        iii. Metastasis
    b. Meningitis, arachnoiditis
    c. Tumors
        i. Meningioma
        ii. Neurofibroma
        iii. Secondaries
    d. Miscellaneous
        i. Lathyrism
        ii. Hereditary spastic paraplegia
        iii. Motor neuron disease
        iv. Tropical spastic paraplegia
        v. Subacute combined degeneration of the cord
        vi. Demyelinating disorders
        vii. Toxins – Poisoning (triorthocresyl phosphate)
3. Roots and peripheral nerves
    a. Guillain-Barré syndrome
    b. Arachnoiditis
    c. Peripheral neuritis
4. Diseases of muscles

Pure spastic paraplegia (paraplegia in extension)

1. General examination
    a. Specifically look for
        i. Pallor (vitamin B12 deficiency)
        ii. Café-au-lait spots (neurofibroma)
        iii. Cervical spondylosis
        iv. Thoracic spine – Gibbus (Pott's spine), surgical scar of old surgery, tenderness
        v. Back stiffness – Arachnoiditis
2. Neurological examination
    a. Higher functions – Usually normal
    b. Cranial nerves – Optic atrophy (multiple sclerosis, B12 deficiency)
    c. Motor system
        i. Upper limbs normal
        ii. Spasticity lower limbs
        iii. Weakness peripheral > proximal
        iv. Exaggerated reflexes
        v. Extensor plantar response
        vi. Clonus (±)
        vii. Beevor's sign may be present with lesion at T10 level
        viii. Abdominal muscle weakness may be present
    d. Sensory system – Normal
    e. Urinary bladder
        i. Hesitancy, precipitancy of micturition
    f. Gait
        i. Spastic (scissors) gait

Spastic quadriplegia

Pure spastic quadriplegia is due to lesions involving corticospinal tracts above C4 spinal segment. Motor and other findings are similar to spastic paraplegia except that upper limbs are similarly involved. Short neck with low hairline, limitation of cervical spine movements and wasting of small muscles of hand suggest craniovertebral anomaly.

Etiology

- Cord compression
- Multiple sclerosis
- Primary lateral sclerosis
- Hereditary spastic paraplegia
- Lathyrism
- B12 deficiency
- Tropical spastic paraplegia/human T-lymphotropic virus-1-associated myelopathy

Spinal cord compression

Clinical features depend upon the specific location of tumor in relation to the cord (Fig. 5.34).

Extradural compression – (trauma, osteomyelitis, abscess, metastasis)

Initial symptoms are due to root compression. Symptoms of cord compression appear later.

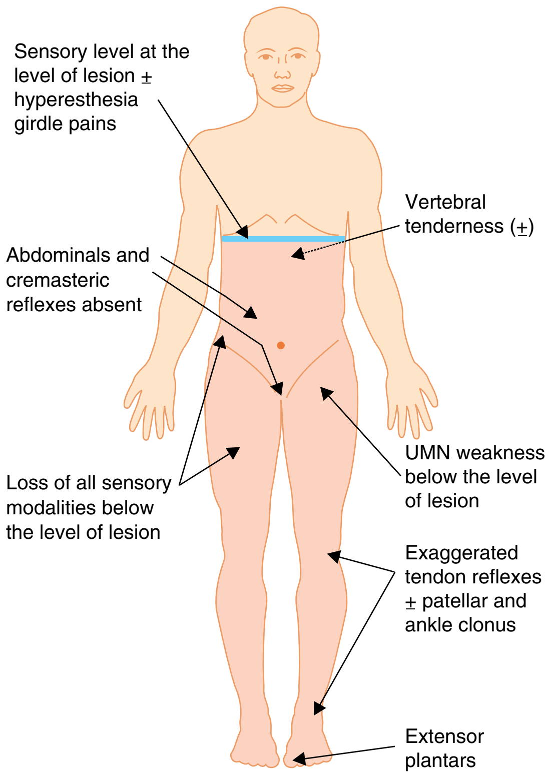

Sensory level at the level of lesion ± hyperesthesia girdle pains
Vertebral tenderness (±)
Abdominals and cremasteric reflexes absent
UMN weakness below the level of lesion
Loss of all sensory modalities below the level of lesion
Exaggerated tendon reflexes ± patellar and ankle clonus
Extensor plantars

Figure 5.34 Salient features of spinal cord compression.

Symptoms of root compression

- Root pains, paresthesias followed by sensory loss
- Lower motor neuron weakness in the distribution of involved roots

Symptoms of cord compression

- Progressive spastic paraplegia/quadriplegia
- Impaired proprioception and cutaneous sensations
- Loss of sphincter control (a late feature)
- Manifestations are often asymmetric

Other findings

- Local pain (an early symptom)
- Deformity of spine

Intradural – extramedullary compression (meningioma, neurofibroma)

- Pain localized to one segment (less common than with extradural compression)
- Lower motor neuron paralysis in the distribution of involved root
- Paraparesis/quadriparesis
- Sensory loss
- Bladder rarely involved

Intramedullary compression (glioma, ependymoma) (Fig. 5.35)

Clinical manifestations

- Progressive paraparesis
- Dysesthesia (burning pain) with progressive sensory loss. Sacral sparing
- Early sphincter dysfunction

Investigations

- Plain X-ray of spine for structural pathologies
- Magnetic resonance imaging or CT. Magnetic resonance imaging is the investigation of choice as it delineates the pathology better

Treatment

- Surgical removal, radiation
- With incomplete or very recent complete loss of function, recovery is possible

Cauda equina/conus medullaris syndromes

Conus is the terminal part of spinal cord, bearing sacral and coccygeal segments. Signs and symptoms are as follows:

- Saddle anesthesia – (S3–S5 segments)
- Retention of urine and incontinence (flaccid bladder)
- Fecal incontinence

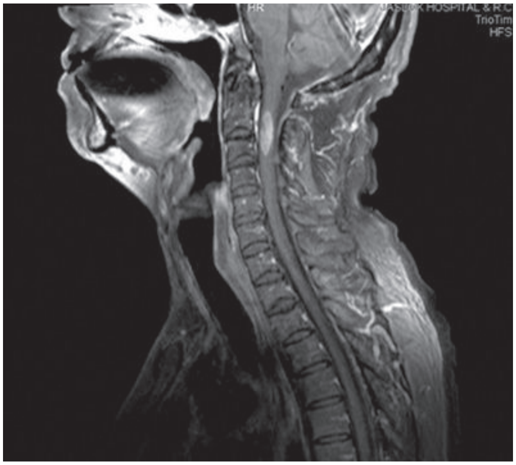


Figure 5.35 Magnetic resonance imaging of spinal cord. Cord tumor (astrocytoma).

- Impotence
- Absent bulbocavernous and anal reflexes

Cause – intramedullary SOL (classically ependymoma)

Cauda equina is formed by lower lumbar and sacral roots, coursing downward to exit from respective intervertebral foramina. Signs and symptoms are

- Low back pain
- Radicular pain
- Asymmetric lower limb weakness
- Asymmetric lower limb sensory loss
- Relative sparing of bladder and bowel functions

Mixed lesions

External compression can cause combined cauda-conus involvement.

Brown-Sequard syndrome

It is due to hemisection of the cord (Fig. 5.36) typically due to penetrating injury. It results in

- Ipsilateral spastic paralysis (pyramidal tracts)
- Ipsilateral loss of posterior column sensations
- Loss of contralateral pain and temperature sensations below the level of lesion
- Ipsilateral brisk reflexes and extensor plantar response

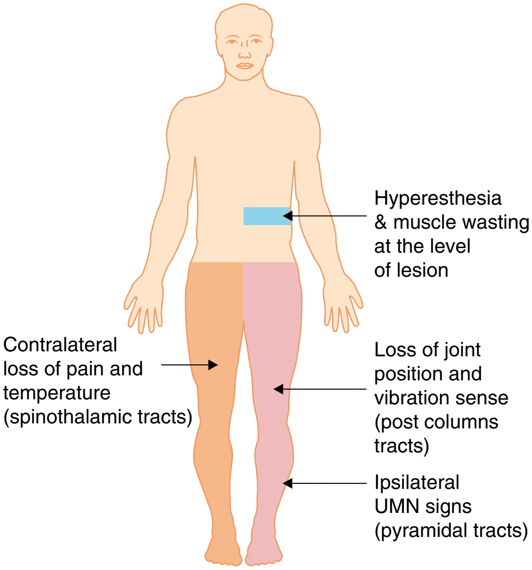

Hyperesthesia & muscle wasting at the level of lesion
Contralateral loss of pain and temperature (spinothalamic tracts)
Loss of joint position and vibration sense (post columns tracts)
Ipsilateral UMN signs (pyramidal tracts)

Figure 5.36 Clinical features of Brown-Sequard syndrome (hemisection of the cord on the left side).

Subacute combined degeneration of the cord

Subacute combined degeneration (SCD) of the cord is due to vitamin B12 deficiency. Neurologic involvement can be present without hematological manifestations (Fig. 5.37).

1. Neurologic symptoms/signs
   a. Irritability, mild depression, paranoia, delirium, confusion
   b. Optic neuritis
   c. Upper motor neuron weakness of lower limbs
   d. Impaired position and vibration sense over lower limbs. Positive Romberg's test
   e. Gloves and stocking sensory loss
   f. Depressed or absent ankle reflexes with exaggerated knee reflexes
   g. Bilateral extensor plantars
   h. Spastic, ataxic gait
2. Other findings
   a. Pallor
   b. Glossitis ± (due to vitamin B complex deficiency)
   c. Mild icterus (lemon yellow color)
   d. Splenomegaly
   e. Hepatomegaly
3. Diagnosis
   a. Characteristic clinical features
   b. Low serum B12 (less than 200 pg/ml)
4. Other investigations
   a. RBC folate
   b. Investigations for the cause of B12 deficiency (diet, malabsorption, pernicious anemia)
   c. Bone marrow may show megaloblastosis
5. Treatment
   a. Parenteral B12
   b. Correct the underlying cause

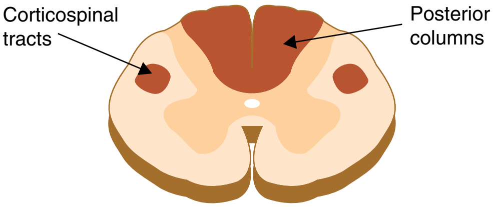

Corticospinal tracts
Posterior columns

Figure 5.37 Subacute combined degeneration of the cord.

Acute transverse myelitis

Acute transverse myelitis is due to inflammatory pathology of the cord. Thoracic cord is most commonly involved.

1. Etiology
    - a. Postviral
    - b. Postimmunization
    - c. Vasculitis
    - d. Drug abuse – (Amphetamine, heroin)
    - e. Infection – Tuberculosis, syphilis
    - f. Unknown
2. Clinical features
    - a. Progressive weakness and sensory loss of the lower limbs, sometimes with sparing of posterior column sensations
    - b. Retention of urine
    - c. Bowel incontinence
    - d. Headache
    - e. Localized backache
    - f. Neck stiffness
3. Differential diagnosis
    - a. Guillain-Barré syndrome
    - b. Cord compression
    - c. Multiple sclerosis
    - d. Anterior spinal artery thrombosis
4. Investigations
    - a. CSF shows increased cells and proteins
    - b. Magnetic resonance imaging (most useful diagnostic modality) (Fig. 5.38)
5. Treatment
    - a. General measures
        - i. Adequate nutrition and fluid intake
        - ii. Prevention of bed sores
        - iii. Prevention of respiratory infections
        - iv. Intermittent bladder catheterization
        - v. Prompt treatment of urinary tract infection
        - vi. Laxative to prevent constipation
        - vii. Early institution of physiotherapy – Initially, passive movements (to prevent contractures); with recovery-graded exercises
        - viii. Rehabilitation
    - b. Treatment
        - i. Treatment of underlying cause
        - ii. Corticosteroids for demyelinating disorders and autoimmune diseases
        - iii. Baclofen for excessive spasticity. Rhizotomy for severe unresponsive spasticity
6. Prognosis
    - a. Recovery often incomplete

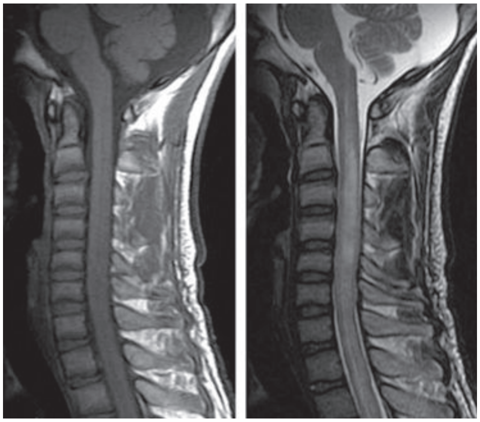


Figure 5.38 Magnetic resonance imaging of spinal cord. Myelitis of cervical cord – bright signal in cord on T2-weighted image.

Craniovertebral junction anomalies

Craniovertebral junction anomalies form an important group of treatable causes of spinal cord compression. These can be:

1. Developmental (fusion of atlas and occipital bone, basilar invagination, atlantoaxial subluxation (Fig. 5.39), platybasia). Platybasia is usually asymptomatic.
2. Acquired due to trauma (associated with high mortality), rheumatoid arthritis, ankylosing spondylitis, infection (tuberculosis), metastasis and Paget's disease of bone.
3. Clinical manifestations
    - a. Short neck, limited range of neck movements
    - b. Cerebellar, lower cranial nerve, brain stem and spinal cord compression signs

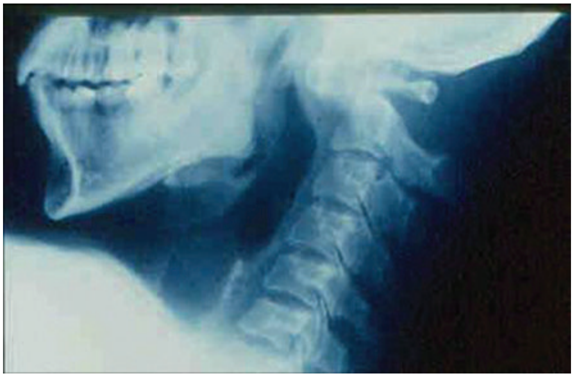


Figure 5.39 Cervical spine lateral view in flexion – Atlantoaxial subluxation.

4. Diagnosis – X-rays do not visualize atlantoaxial-occipital junction area well; CT or MRI is preferred.
5. Treatment
    a. Neck support
        i. Surgical stabilization, decompression
        ii. Treatment of underlying cause

Cervical spondylosis

It is a degenerative disorder of intervertebral discs (and annulus) with the formation of bony osteophytes. Neurologic symptoms are due to narrowing of cervical canal causing cord compression and narrowing of intervertebral foramina causing radiculopathy.

1. Clinical features
    a. Radicular pains and weakness with wasting of upper extremity muscles
    b. Spasticity in lower limbs, with exaggerated DTR and extensor plantars
    c. Impaired vibration sense in lower limbs
    d. Limitation of cervical spine movements
2. Diagnosis
    a. X-ray cervical spine (AP, lateral, oblique views)
    b. Magnetic resonance imaging (in the presence of neurologic manifestations)
    c. Electromyogram (EMG), nerve conduction (NC) studies, somatosensory and motor-evoked potentials
3. Treatment
    a. Surgery for myelopathy and for radiculopathy not relieved by conservative treatment
    b. Conservative treatment – Soft collar, analgesics or NSAIDs

Viva voce

Q1. Explain paraplegia in flexion and extension?

Inherently, flexors of lower limbs are stronger than the extensors. The muscle tone is dependent upon the influence of corticospinal, extrapyramidal and cerebellar systems on the spinal reflex arc. With corticospinal tract dysfunction, extrapyramidal influence (reticulospinal tracts) becomes prominent, resulting in paraplegia in extension. When these too become dysfunctional, the flexor reflex dominates, resulting in paraplegia in flexion. Paraplegia in flexion suggests significant cord damage with poor chances of recovery.

Q2. What are flexor spasms? What is their significance?

Flexor spasms indicate a state of transition from paraplegia in extension to paraplegia in flexion (from mild cord damage to severe cord damage or from reversible to irreversible damage). There is sudden flexion at ankle, knee and hip joints with extension of great toe. Occasionally, there is spontaneous voiding of urine (mass reflex). Spasms may be spontaneous or triggered by a stimulus (e.g. touch) applied to the lower limbs. Flexor spasms are an indication for urgent treatment (decompression) to prevent change from potentially reversible to irreversible neurodeficit.

Urinary tract infection, infected bed sores and lack of physiotherapy are important aggravating factors.

Q3. What is spinal shock?

Acute insult (trauma, inflammation, infarction) to the cord results in spinal shock, which is a flaccid, areflexic paralysis below the level of spinal cord lesion. Extensor plantar response may be present. There is urinary retention and constipation. Recovery is indicated by reappearance of tone, muscle power and DTR in any sequence. The final functional recovery depends upon the degree of recovery of tone, muscle strength, and the duration of spinal shock. Longer the duration of shock more are the chances of incomplete or poor recovery.

Motor neuron diseases

Motor neuron diseases are a group of progressive, degenerative disorders involving corticospinal tracts, AHCs, bulbar motor nuclei, singly or in combination. Briefly, clinical types and their features are as follows:

Amyotrophic lateral sclerosis (Fig. 5.40)

- Amyotrophic lateral sclerosis is the most common form of MND
- Onset is often with cramps, weakness and atrophy of muscles of hands or feet in a random, asymmetric fashion. Later, proximal and bulbar muscles are involved
- Signs – There is a combination of UMN and LMN paralysis with predominantly LMN signs in upper limbs and UMN signs in lower limbs

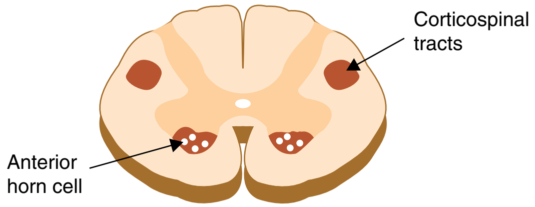


Figure 5.40 Amyotrophic lateral sclerosis (lesions in the spinal cord).

- Fasciculations (characteristic, diagnostic)
- With the involvement of brain stem, patient develops dysphagia, slurred speech and chokes on liquids. Later, features of pseudobulbar palsy develop (inappropriate, involuntary, uncontrollable laughter or crying with positive jaw jerk).
- Consciousness, external ocular muscles, sensations, bladder, sphincter and sexual functions are not involved.
- Prognosis: 50% die in 3 years, mostly due to respiratory muscle failure

Progressive bulbar palsy

- There is progressive involvement of motor cranial nerve nuclei and corticobulbar tracts
- Mastication, articulation and swallowing are affected
- Fasciculations and wasting of tongue are present
- Pseudobulbar symptoms and signs are present
- Dysphagia is a poor prognostic sign
- Death is due to aspiration

Progressive muscular atrophy

- There is LMN affection of upper and lower limbs
- Progression is slow with long survival
- Fasciculations are prominent

Differential diagnosis of ALS

- Arnold–Chiari malformation
- Spinal cord compression
- Cervical spondylosis
- Subacute combined degeneration of the cord
- Syringomyelia
- Parasagittal or foramen magnum tumor
- Autoimmune polyradiculoneuropathy
- Motor neuropathy
- Diabetic amyotrophy
- Paraneoplastic

Viva voce

Q1. What are the causes of pseudobulbar palsy?

- Motor neuron disease
- Multiple sclerosis
- Brain tumor
- Double hemiplegia with lesion at or above internal capsules level
- Multiple cerebral infarctions

Q2. What are the causes of fasciculations?

- Can be normally present
- Motor neuron disease (most classical cause)
- Organophosphorous poisoning
- Acute phase and recovery phase of poliomyelitis
- Drugs – clofibrate, salbutamol, lithium, edrophonium, neostigmine
- Thyrotoxicosis
- Cervical spondylosis
- Syringomyelia
- Spinal muscular atrophy
- Peroneal muscular atrophy

Q3. What are the causes of wasting of small muscles of both hands?

- Leprosy
- Rheumatoid arthritis
- Cervical spondylosis
- Motor neuron disease
- Syringomyelia
- Thoracic outlet syndrome
- Charcot–Marie–Tooth disease
- Myotonic dystrophy
- Disuse (old age)

Syringomyelia/syringobulbia

Syrinx is a fluid-filled cavity within the spinal cord (syringomyelia) or brain stem (syringobulbia). Commonest site is in the cervical cord. The cavity is paramedian (Fig. 5.41A) in location

1. **Predisposing factors**
   - Congenital – Often associated with craniovertebral junctional anomalies (Chiari malformation)
   - Intramedullary tumors
   - Spinal trauma
2. **Clinical features**
   - **a.** Spinal cord syringomyelia
     - **i.** Painless burns (often the first manifestation)

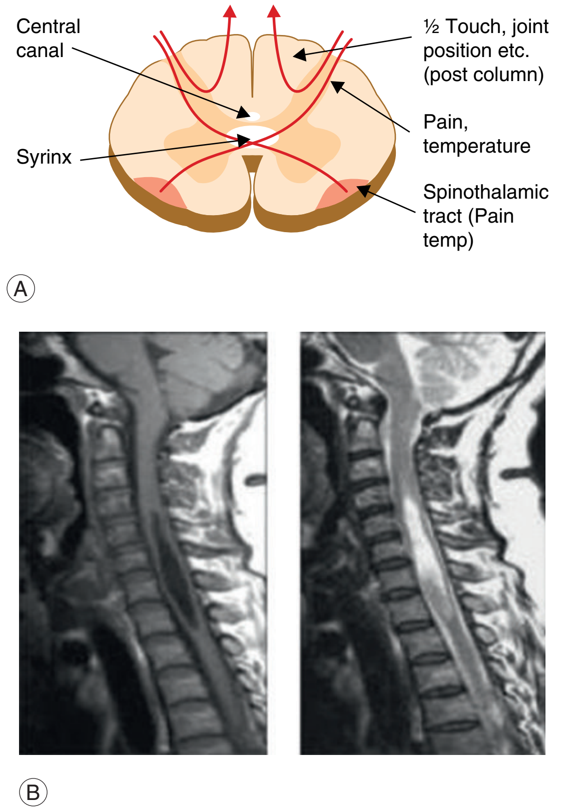

Central canal
½ Touch, joint position etc. (post column)
Pain, temperature
Syrinx
Spinothalamic tract (Pain temp)
A
B

Figure 5.41 (A) Syringomyelia (lesions in the spinal cord). (B) Magnetic resonance imaging of spinal cord. Syringomyelia fluid intensity lesion in cervical cord.

      - **ii.** Suspended segmental loss of pain and temperature sensation (dissociate anesthesia)
      - **iii.** Lower motor neuron signs at the level of the lesion with absent DTR
      - **iv.** Corticospinal dysfunction in lower limbs with urinary bladder involvement (late manifestation)
      - **v.** Scoliosis almost always present
   - **b.** Brain stem syringobulbia
      - **i.** Vertigo
      - **ii.** Nystagmus
      - **iii.** Unilateral loss of pain and temperature sensations of face
      - **iv.** Dysphagia, dysarthria, hoarseness of voice
      - **v.** Atrophy of tongue
      - **vi.** Sensory and motor manifestations are not always present
- **3.** Differential diagnosis
   - **a.** Intramedullary tumor
   - **b.** Vascular malformation
- **4.** Investigations
   - **a.** Magnetic resonance imaging with gadolinium enhancement (Fig. 5.41B) or CT myelogram
   - **b.** X-ray cervical spine may show widening of spinal canal and craniovertebral anomaly
- **5.** Treatment
   - **a.** Drainage of syrinx with removal of obstruction to CSF flow
   - **b.** Treatment of associated disorders

Cerebellar ataxia

The disorders affecting cerebellar system (cerebellum and its connections) are varied.

- **1.** Etiology
   - **a.** Congenital malformation, e.g. Arnold–Chiari malformation
   - **b.** Degenerative disorders – Friedreich's ataxia
   - **c.** Drugs – Phenytoin, lithium
   - **d.** Toxins – Alcohol, mercury, cytotoxic chemotherapeutic drugs
   - **e.** Nutritional – Vitamin B1, B12 deficiency
   - **f.** Endocrine – Hypothyroidism
   - **g.** Paraneoplastic – Bronchogenic carcinoma
   - **h.** Vascular – Cerebrovascular accident
   - **i.** Space occupying lesion – Cerebellar glioma, metastasis, cerebello-pontine angle tumor
   - **j.** Infection – Viral, postencephalitic, abscess
   - **k.** Demyelination – MS, AIDS related
   - **l.** Trauma – Subdural hematoma
- **2.** Signs and symptoms – Ataxia is the main symptom. (For details, refer motor system examination.)
- **3.** Diagnosis
   - **a.** Family history
   - **b.** Clinical findings
   - **c.** Magnetic resonance imaging
   - **d.** Investigations for specific cause
- **4.** Treatment
   - **a.** As per the cause
   - **b.** Genetic counseling as indicated

Friedreich's ataxia

- Most common hereditary ataxia
- Recessive inheritance
- Onset before the age of 25 years
   - **1.** Clinical manifestations
      - **a.** Ataxia, lower limbs > upper limbs

   b. Optic atrophy, nystagmus, slow eye movements
   c. Dysarthria
   d. Weakness distal > proximal
   e. Loss of vibration and proprioception sensations
   f. Peripheral neuropathy, absent ankle reflexes
   g. Extensor plantars
   h. Cardiomyopathy
   i. Skeletal abnormalities – Peseavus, scoliosis, telepes equino varus

2. Diagnosis
   a. Clinical
   b. Magnetic resonance imaging to exclude other causes

3. Treatment
   a. There is no specific treatment

Viva voce

Q1. What are the causes of absent ankle reflex with extensor plantar response?

- Subacute combined degeneration of the cord
- Cervical plus lumbar spondylosis
- Spinal shock
- (High) Lesions of conus medullaris
- Motor neuron disease
- Friedreich's ataxia
- Taboparesis

Extrapyramidal diseases

Caudate nucleus, putamen, globus pallidus and substantia nigra constitute the EPS. Extrapyramidal system is intimately connected with cerebral cortex and cerebellum. Disorders of EPS manifest as movement disorders (dyskinesia), e.g. slow movements (hypokinesia), excessive or abnormal movements (hyperkinesia).

Parkinson's disease (Fig. 5.42)

It is a progressive degenerative disorder of nervous system of unknown etiology. There is loss of dopaminergic neurons of the basal ganglia.

Clinical features

1. Onset and general examination
   a. Onset in the 6th or sometimes in the 5th decade
   b. Insidious onset
   c. Mentation usually normal, depression may be present
   d. Monotonous, stuttering speech
   e. Hypophonia
   f. Mask-like facial expression, infrequent blinking, positive glabellar sign
   g. Staring look
   h. Jaw and tongue tremor
   i. Bradykinesia, hypokinesia, akinesia

2. Extremities
   a. Normal muscle strength
   b. Lead pipe or cogwheel rigidity
   c. Pin rolling tremors
   d. Normal sensations
   e. Bradykinesia, micrographia, slow-alternating movements
   f. Normal DTR
   g. Flexor plantar response

3. Posture, gait
   a. Stooped posture, slow shuffling gait, loss of arm swing, arms held in flexed attitude
   b. Festination, propulsion, retropulsion
   c. Difficulty in getting up and in stopping
   d. Turning slow and in short arcs

4. Other findings
   a. Drooling of saliva
   b. Seborrheic dermatitis

5. Findings that suggest secondary parkinsonism
   a. Dementia
   b. Vertical gaze palsy (Steele–Richardson–Olszewski syndrome)

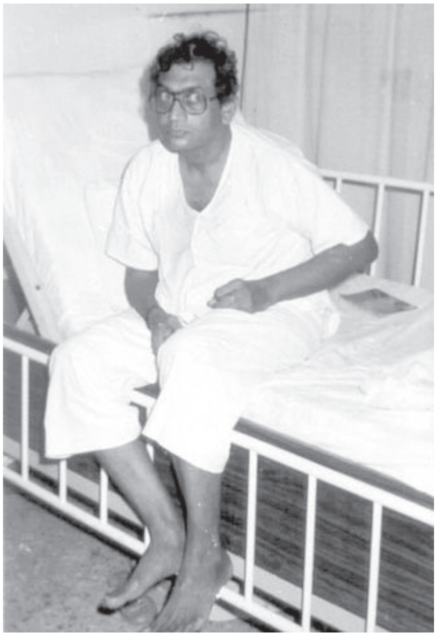


Figure 5.42 Parkinsonian posture.

   c. Tardive dyskinesia (Iatrogenic)
   d. Long-tract signs (Steele–Richardson–Olszewski syndrome, Shy–Drager syndrome, multisystem degeneration)
   e. Oculogyric crisis (postencephalitic)
   f. Kayser–Fleischer (KF) rings (Wilson's disease)
   g. Progressive supranuclear palsy
6. Treatment
   a. Drugs
      i. Levodopa, carbidopa
      ii. Amantadine
      iii. Bromocriptine, pergolide
      iv. Selegiline, rasagiline
      v. Anticholinergics, antihistamines with anticholinergic effect
      vi. Catechol-O-methyltransferase (COMT)
   b. Surgery – Pallidotomy
   c. Physiotherapy
   d. High-fiber diet (to prevent constipation)

Rheumatic chorea

It is a late manifestation of rheumatic fever. Usually develops after other manifestations of rheumatic fever have subsided. Onset is usually insidious.

Neurological findings

Emotional disturbances (often present)
Halting and explosive speech
Normal cranial nerves

Motor system

- Normal muscle mass
- Hypotonia
- Normal or reduced power
- Rapid, jerky, irregular movements involving hands and often whole of upper extremity, face and feet (subjectively purposeful, objectively purposeless movements)

Sensory system

Normal

Reflexes

- DTR +/−
- Plantars – Flexor

Special signs

- Restless, fidgety
- Facial grimacing
- Wormian tongue – (protruded tongue darts in and out)
- Pronator sign (extended hands held above head assume pronated posture)
- Milkmaid's grip or milking sign (when patient squeezes examiner's hand, irregular contractions are felt)
- Clumsiness – Dropping of objects
- Signs of rheumatic fever – Usually absent

Huntington's chorea (disease)

Clinical features

- Positive family history
- Insidious onset between 35 and 50 years of age
- Involuntary movements (chorea, facial grimacing)
- Dementia or psychiatric disorder
- Ataxia
- Dystonia

Viva voce

Q1. What are the causes of chorea?

- Rheumatic fever (Sydenham's chorea)
- Huntington's chorea
- Thyrotoxicosis
- Systemic lupus erythematosus
- Pregnancy (chorea gravidarum)
- Senile or arteriosclerotic
- Drugs (antipsychotics)

Peripheral nervous system disorders

Peripheral nervous system includes cranial and spinal nerves. Motor component extends from AHCs to myoneural junctions and the sensory component from peripheral nerve endings to cord or brain stem. The term peripheral nerve excludes nerve roots and plexuses. Mononeuritis is involvement of a single nerve, while mononeuritis multiplex is involvement of multiple nerves. When peripheral nerve involvement is symmetrical, the term polyneuropathy is used. Polyneuropathy may be proximal (e.g. Guillain-Barré syndrome) or distal (peripheral neuritis).

Peripheral neuritis

1. **Etiology**
   - Diabetes mellitus
   - Alcohol
   - Vitamin B12 deficiency

- Vitamin B1 deficiency
- Drugs, e.g. isoniazid, vincristine, dapsone, thalidomide
- Critical illness
- AIDS
- Malignancy
- Toxins – Arsenic, organophosphorous compounds
- Systemic connective tissue diseases, e.g. rheumatoid arthritis, systemic lupus erythematosus, vasculitis
- Sarcoidosis

2. **Clinical features**
   - Onset may be acute, subacute or chronic
   - Distal involvement > proximal
   - May be purely motor, sensory or mixed
   - Pathologically may be demyelinating, axonal or mixed
   - Motor involvement manifests with weakness, wasting of muscles and depressed or absent DTR
   - Sensory involvement may manifest as paresthesia or loss of sensations (all or spinothalamic, posterior column sensations in isolation)
   - Autonomic features such as trophic changes and vasomotor disturbances may be present
   - In addition, signs and symptoms of underlying cause may be present, e.g. thickened nerves + anesthetic patch (leprosy), signs of B complex deficiency, signs of systemic rheumatic disease
3. Investigations
   - Electromyogram/NC studies if diagnosis is not clear
   - Investigations to identify the etiology
4. Management
   - Treatment of underlying cause
   - Symptomatic
   - Paresthesia – Carbamazepine, amitriptyline
   - Weakness – Physiotherapy
   - Prevention of injury; foot care

Guillain-Barré syndrome (GBS) (Landry's ascending paralysis)

- The most common acquired demyelinating neuropathy
- Possibly autoimmune in nature

1. Symptoms and signs
   - Acute onset. A febrile episode may precede the illness
   - Rapidly progressive muscular weakness, starting in legs and progressing to arms
   - Facial and oropharyngeal muscle paralysis
   - Bladder and bowel usually not involved
   - Maximum weakness by 3 weeks. Respiratory failure in patients with severe disease
   - Sensory symptoms – absent or minimal
   - Deep tendon reflexes – lost
   - Autonomic disturbances, syndrome of inappropriate antidiuretic hormone secretion, cardiac arrhythmias and pupillary abnormalities with severe disease
   - mortality 5%
2. Diagnosis
   - Clinical
   - CSF shows disproportionate increase in proteins, compared to cells
   - Nerve conduction study (not always necessary) shows
     - i. Slowing of nerve conduction velocities
     - ii. Segmental demyelination
     - iii. Prolonged F-wave latencies with proximal (nerve root) involvement
3. Differential diagnosis
   - Organophosphorous poisoning
   - Botulism
   - Acute anterior poliomyelitis
   - Tick bite
4. Prognosis
   - Majority of patients recover
   - Ten percent develop chronic relapsing polyneuropathy
5. Treatment
   - a. General measures
     - Guillain-Barré syndrome is a medical emergency. Close monitoring of vital functions is essential
     - SOS respiratory assistance
     - Maintain adequate urine output (1–1.5 liters/day)
     - Prevent bedsores
     - Early physiotherapy with passive full range of movements
     - Pain relief
     - Deep venous thrombosis (DVT) prophylaxis (LMW heparin)
   - b. Drugs
     - Plasmapheresis – Treatment of choice in early disease, alternatively intravenous immunoglobulin
     - Corticosteroids have no role

Chronic relapsing polyradiculopathy

- A variant of GBS
- More asymmetric involvement
- Slow progression
- Episodes of demyelination and remyelination present; may result in thickening of nerves

Treatment

- Corticosteroids (prolonged treatment)
- Immunosuppressive therapy
- Plasmapheresis

Charcot–Marie–Tooth disease (peroneal muscular atrophy)

It is a hereditary disorder, predominantly affecting muscles of the peroneal compartment. Disease onset is in the middle childhood.

Clinical manifestations

- Foot drop
- Atrophy of leg muscles giving an inverted dumb-bell or champagne bottle appearance
- Wasting of muscles of hand
- Gloves and stocking anesthesia

There is no specific treatment

Viva voce

Q1. What are the causes of pure sensory neuropathy?

- Diabetes mellitus
- Alcohol
- Isoniazid (INH), vincristine, furadantin
- Nutritional (B1, B12) deficiency
- Uremia
- Amyloidosis

Q2. What are the conditions associated with both cranial and peripheral nerve involvement?

- Leprosy
- Diphtheria
- Guillain-Barré syndrome
- Diabetes mellitus
- Sarcoidosis
- Vitamin B12 deficiency
- Alcohol
- Friedreich's ataxia

Muscular dystrophies

These are inherited progressive disorders, characterized by selective pattern of atrophy and pseudohypertrophy of muscles.

Duchenne's muscular dystrophy

Clinical features

- Onset in early childhood (2–3 years of age)

Neurological findings

- Mild intellectual impairment with impaired verbal ability
- Proximal muscle weakness
- Pseudohypertrophy of muscles, most commonly of calf muscles (Herculean calves)
- Normal DTR
- Normal sensations
- Waddling gait, lordosis, toe walking, frequent falls
- Difficulty in climbing stairs, rising from floor. Gowers' maneuver (characteristic finding)
- Wheel chair bound by the age of 12 years

Becker's muscular dystrophy

- Onset in late childhood or adolescence
- Milder disease
- Slower progression, patient remains ambulant up to or beyond 15 years of age

Demyelinating disorders

Myelin sheath covers nerve fibers of central and peripheral nervous system. Its function is to accelerate nerve conduction. Central and peripheral myelin differ antigenically. Thus, some demyelinating disorders affect only central myelin (e.g. Multiple sclerosis) or peripheral myelin (e.g. Guillain-Barré syndrome).

There are many causes of demyelination, e.g. hereditary disorders, infection, metabolic, ischemic and autoimmune disorders. Demyelination tends to be patchy and multifocal. Regeneration of myelin with recovery of function is possible. Extensive myelin loss results in irreversible neurodeficit.

Multiple sclerosis (MS)

It is a recurrent, progressive disorder characterized by dissemination in time and space of demyelination involving brain and spinal cord. Neurological findings vary from time to time.

1. Clinical features
    a. Higher functions
        i. Mild cognitive impairment
        ii. Apathy, inattention
        iii. Depression, euphoria

- **b.** Cranial nerves
  - **i.** Unilateral or asymmetric optic neuritis with loss of vision
  - **ii.** Fundus-papillitis or optic atrophy
  - **iii.** Internuclear ophthalmoplegia
  - **iv.** Impaired or lost direct light reflex
  - **v.** Dysarthria
- **c.** Motor system
  - **i.** Spastic weakness of lower limbs
  - **ii.** Occasionally hemiplegia
  - **iii.** Intention tremors
  - **iv.** Exaggerated knee and ankle reflexes
  - **v.** Extensor plantar response
  - **vi.** Clonus
  - **vii.** Flexor spasms (late manifestation)
- **d.** Cerebellar signs
  - **i.** Slurred, scanning speech
  - **ii.** Nystagmus
  - **iii.** Cerebellar ataxia
- **e.** Sensory system
  - **i.** Partial, localized loss of any sensory modality
- **f.** Others
  - **i.** Constipation
  - **ii.** Bladder dysfunction
  - **iii.** Erectile dysfunction
  - **iv.** Lhermitte's sign – On neck flexion, an electric shock-like pain radiates down the spine or legs

    (Any evidence of LMN involvement or peripheral nerve involvement negates the diagnosis of MS).

Devic's disease

Devic's disease is acute optic neuritis (unilateral or bilateral) along with demyelination of the cord.

Diagnosis

Clinical – optic neuritis plus paraplegia

Investigations

MRI	Most sensitive diagnostic modality, gadolinium enhancement helps to diagnose active plaques. Alternatively CT with contrast enhancement
CSF	Increased proteins (IgG) (oligoclonal) Lymphocytosis
	Evoked sensory and visual potentials – delay in evoked electrical responses

Treatment

- Corticosteroids (high dose) short course(s) for acute manifestations
- Immunosuppressive therapy to decrease attack frequency (interferon, intravenous immunoglobulin, methotrexate, azathioprine)
- Baclofen or tizanidine for spasticity
- Gabapentin, tricyclic antidepressants for painful paresthesias
- Physiotherapy, rehabilitation

Tuberculous meningitis

- A subacute – chronic meningeal infection
- More common in children
  1. Clinical features
     - **a.** Fever, weight loss, neck stiffness, vomiting, headache
     - **b.** Extraneural tuberculosis often present
     - **c.** Varying degrees of mental obtundation
     - **d.** Fundus may show optic atrophy, papilledema or choroid tubercles
     - **e.** III, IV and VI cranial nerves palsies
     - **f.** Limb weakness (monoplegia, hemiplegia)
     - **g.** Cerebellar and extrapyramidal signs common in children
  2. Diagnosis/investigations
     - **a.** Most common cause of chronic meningitis
     - **b.** CSF shows mild, predominantly lymphocytic pleocytosis, raised proteins, low sugar and low chloride with cobweb formation.
     - **c.** CSF for acid-fast bacillus (detection difficult), mycobacterial culture, polymerase chain reaction
     - **d.** X-ray chest may show tuberculosis
     - **e.** Neuroimaging in the presence of neurodeficit
  3. Treatment
     - **a.** Standard antitubercular treatment
     - **b.** Steroids for the 1st 6 weeks of treatment
     - **c.** Treatment of complications like obstructive hydrocephalus, raised ICP

Viva voce

Q1. What are the causes of chronic meningitis?

Infection

- Tuberculosis
- Syphilis

- Cryptococcus
- Actinomycosis (especially in patients with AIDS or patients on long-term immunosuppressive therapy)
- Viral infections

Aseptic (non infectious)

- Postinfectious
- Drugs
- Behcet's disease
- Sarcoidosis
- Parameningeal disease (sinusitis, otitis, tumor)
- Reaction to intrathecal injections
- Reaction to vaccines and toxins

Cranial nerve palsies

Cranial nerve paralysis may involve one or multiple cranial nerves. The clinical features of individual cranial nerve paralysis are described under clinical methods.

Causes of III cranial nerve palsy

- Diabetes mellitus
- Vasculitis
- Migraine
- Posterior communicating artery aneurysm
- Wernicke's encephalopathy
- Midbrain infarction
- Midbrain SOL (Fig. 5.43A,B) resulting in bilateral III cranial nerves palsy

Causes of VI cranial nerve palsy

- Diabetes mellitus
- Nasopharyngeal tumors
- Increased ICP
- Trauma
- Basal meningitis
- Pontine stroke, tumor
- Wernicke's encephalopathy

Causes of palsy of VI cranial nerve

- Ramsay Hunt syndrome
- Nasopharyngeal carcinoma, cerebellar and pontine tumors
- **Gradenigo's syndrome** (due to localized meningitis secondary to infection involving petrous temporal bone, affects V and VI cranial nerves)
- Internal carotid artery aneurysm
- Increased ICP

Causes of VII cranial nerve palsy

- Bell's palsy
- Ramsay Hunt syndrome
- Leprosy
- Sarcoidosis
- C-P angle tumor
- Pontine infarction, tumor
- Guillain-Barré syndrome

Bell's palsy (palsy of VII cranial nerve)

(For symptoms and clinical features, refer clinical methods section.)

- Etiology unknown. Viral infection and autoimmune disorders are considered possible causes
- There is sudden onset of unilateral palsy of VII cranial nerve

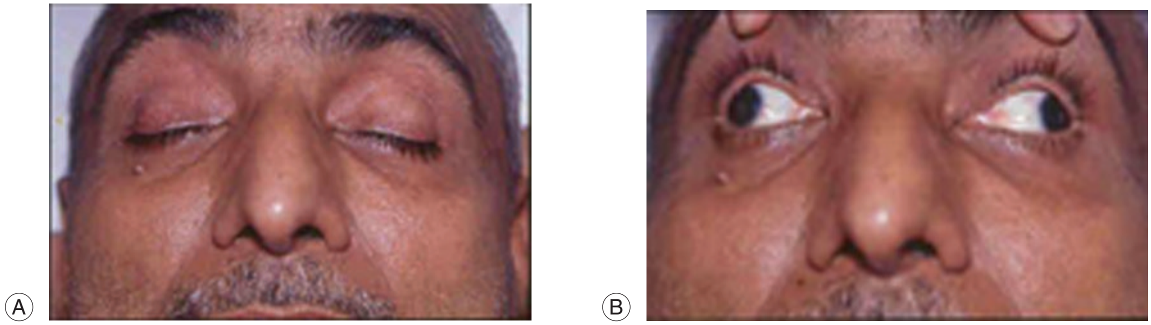


Figure 5.43 (A) Bilateral Palsy of III cranial nerve with complete ptosis. (B) Bilateral III cranial nerve palsy. Position of eyes as seen with eye lids lifted.

- Retroauricular pain may precede onset of facial palsy
- Evolution is rapid and maximum weakness develops in 2–3 days
- Diagnosis is clinical
- There are no specific diagnostic investigations
- There is no specific treatment. Physiotherapy (facial muscle exercises) is the mainstay of treatment
- Corticosteroids given within first 48 hours may help
- Antiviral drugs are advocated (to treat presumed viral infection)
- Measures to prevent corneal drying with frequent eye drops (Natural tears, normal saline, methyl cellulose and intermittent eye closure)

Prognosis

Recovery is variable. Postrecovery abnormalities are contracture facial hemispasm, crocodile tears and abnormal contraction of facial muscles during voluntary movements (due to aberrant innervation)

Viva voce

Q1. Enumerate the causes of multiple cranial nerve palsies

- Basal meningitis – Tuberculous, pyogenic, syphilitic (meningovascular syphilis), carcinomatous (includes lymphoma, leukemia)
- Malignancy – Brain stem SOL (glioma), nasopharyngeal carcinoma, perineural tumor infiltration
- Brain stem tuberculoma
- Diabetes mellitus
- Sarcoidosis
- Vasculitis
- Basilar artery aneurysm
- Paget's disease of bone
- Motor neuron disease
- Poliomyelitis

Q2. What are the causes of optic neuritis?

- Collagen vascular diseases
- Infections (viral encephalitis, sinusitis, meningitis [tuberculosis], syphilis), HIV
- Toxins/drugs – Methyl alcohol, tobacco, antibiotics
- Diabetes mellitus, pernicious anemia, trauma
- Multiple sclerosis

Q3. What are the causes of papilledema?

- Raised ICP
- Venous obstruction (central vein, cavernous sinus, superior vena cava)
- Malignant hypertension
- Vasculitis
- Anemia
- Polycythemia
- Hypercapnia
- Lymphoma, leukemia
- Optic neuritis
- Glioma of optic nerve
- Guillain-Barré syndrome

Q4. What are the differences between papilledema (Fig. 5.44) and papillitis?

	Papilledema	Papillitis
Visual acuity	Preserved till late	Diminished early
Blind spot	Enlarged	Central scotoma
Ocular pain	Absent	Present

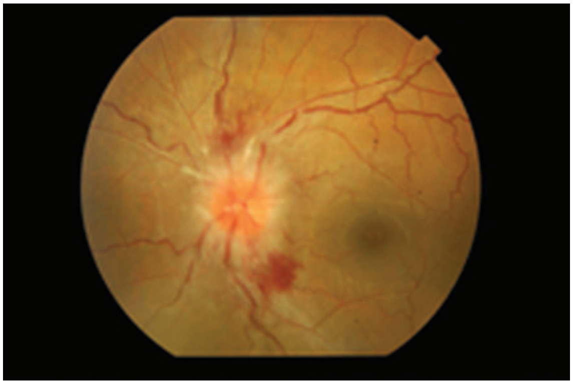


Figure 5.44 Papilledema.

Q5. What are the causes of optic atrophy? (Fig. 5.45)

- Smoking, alcohol
- B12 deficiency
- Multiple sclerosis
- Nerve compression (frontal lobe tumor)
- Glaucoma
- Diabetes mellitus
- Friedreich's ataxia, retinitis pigmentosa
- Ischemia
- Drugs (e.g. ethambutol)
- Tabes dorsalis
- Postpapilledema

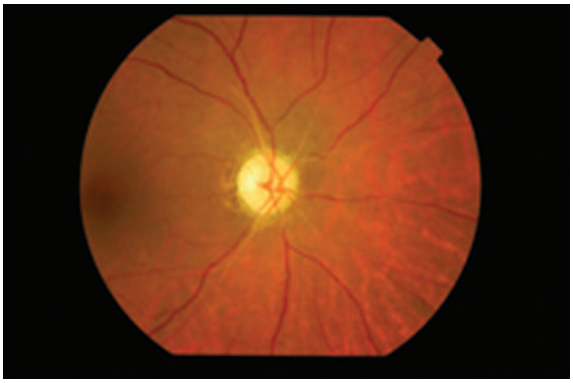


Figure 5.45 Optic atrophy.

Intracranial tumors/SOL

Causes of intracranial SOLs

Tumors

- Astrocytoma
- Oligodendroglioma
- Medulloblastoma (children)
- Acoustic neuroma
- Meningioma
- Craniopharyngioma
- Pituitary adenoma
- Colloid cyst
- Ependymoma
- Metastasis

Others

- Brain abscess
- Granuloma
- Cysticercosis
- Subdural hematoma
- Lymphoma
- Large aneurysm

Viva voce

Q1. What are the symptoms of raised ICP?

1. Due to raised ICP
   - Mental changes
   - Convulsions
   - Progressive loss of consciousness
2. Focal symptoms – Mostly depend upon site of SOL (exception is palsy of VI cranial nerve which can be a false localizing sign)

Q2. What are the signs of raised ICP?

- Altered mental state (drowsiness to coma)
- Neck stiffness
- Focal signs
- Bradycardia
- Respiratory depression, irregular respiration
- False localizing signs
- Palsy of VI cranial nerve
- Corticospinal tract dysfunction (ipsilateral or contralateral)
- Palsy of III cranial nerve
- Cerebellar signs

Q3. What is Foster Kennedy syndrome?

This is caused by retro-orbital tumor (meningioma, hydatid cyst) pressing on optic nerve causing optic atrophy on the side of the compression and papilledema on the opposite side due to raised ICP.

Q4. How do you treat intracranial SOL?

- Lower raised ICP
- Surgical removal whenever possible
- Seizure control
- Radiotherapy
- Chemotherapy

Cerebellopontine (CP) angle tumor

Clinical features

- Ipsilateral tinnitus, hearing loss
- Vertigo, ataxia (with large tumor)
- Ipsilateral facial paralysis, palatal weakness
- Ipsilateral loss or impaired corneal reflex
- Loss of facial sensations
- Other cranial nerve or brain stem deficits
- Raised ICP with large tumor

Viva voce

Q1. What are the causes of altered mentation in an alcoholic?

- Acute intoxication (alcohol, other drugs)
- Acute alcohol withdrawal
- Late alcohol withdrawal (delirium tremens)
- Wernicke's encephalopathy
- Hepatic encephalopathy
- Hypoglycemia
- Postictal
- Head injury (subdural hematoma)
- Sepsis

Q2. What is Wernicke's encephalopathy?

Wernicke's encephalopathy is the result of thiamine deficiency coupled with high carbohydrate diet. Alcoholism is the most common cause. Other causes are food faddism, hyperemesis gravidarum and inadequate postoperative replenishment.

Clinical features

- Rapid development of confusion, stupor
- Nystagmus
- Ataxia
- Ophthalmoplegia
- Autonomic dysfunction (hyper or hypo)

Treatment

Thiamine 100 mg intravenous stat, intravenous fluids, correction of electrolyte disturbances and multivitamins. Glucose should not be given before thiamine administration.

Delirium tremens may supervene a few days later

Q3. What is Korsakoff's syndrome?

Korsakoff's syndrome (KS) may accompany or follow WE or follow delirium tremens. Other causes are subarachnoid hemorrhage, ischemic stroke, head injury and SOL.

Clinical features

- Severe loss of recent memory with relative preservation of past memory
- Confabulation
- Disorientation in time, emotional disturbances
- Prognosis of postalcoholic KS is poor. Poststroke and posthead injury KS patients have a better prognosis.

Q4. Name the disorders of neuromuscular transmission

- Myasthenia gravis
- Eaton–Lambert syndrome
- Stiff man syndrome
- Isaac's syndrome
- Botulism
- Drugs – Cholinergics, organophosphate insecticides, aminoglycoside and polypeptide antibiotics, d-Penicillamine, high doses of magnesium

Q5. What is Eaton–Lambert myasthenic syndrome?

- It is due to circulating antibodies to calcium channels that diminish presynaptic release of acetylcholine at the neuromuscular junction
- A rare disorder
- Common in middle-aged men
- In large majority, associated with small cell lung carcinoma
- Common symptom – Weakness with fatigue, mostly in legs
- Autonomic disturbances
- Ptosis
- Absent or diminished DTRs
- Incremental pattern on EMG
- Treatment – Surgery of the tumor
- Medical treatment – Guanidine, corticosteroids, immunosuppressive drugs, plasmapheresis, intravenous immunoglobulin, diaminopyridine

Q6. What is Sturge–Weber syndrome (SWS)?

Sturge–Weber syndrome is characterized by hemangioma over face with contralateral focal fits, squint, glaucoma, optic atrophy, exophthalmos and spasticity.

Treatment – anticonvulsants.

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Chapter 6

Nephrology

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BASIC CONSIDERATIONS

Kidneys (11–14 cm in size) are retroperitoneal organs lying in paravertebral space in relation to lower thoracic vertebrae. Each kidney contains approximately one million nephrons.

Nephron is the functional unit of kidneys. Kidney is an important organ and is richly supplied with blood (25% of cardiac output at rest). Afferent arterioles (originating from the interlobular branches of renal artery) branch into glomerular capillaries that merge to form efferent arterioles, which then supply blood to renal tubules (proximal and distal convoluted tubules). The medulla is supplied by the arterioles arising from the glomeruli. The glomerulus is a bunch of capillaries placed in Bowman's capsule. Juxtaglomerular apparatus (JGA) that secretes renin is a collection of specialized cells lying near the junction of afferent arteriole and distal convoluted tubule (Fig. 6.1).

Blood while passing through the glomerular capillaries filters out (by the process of diffusion) water and solutes across the glomerular capillary membrane. In normal persons, glomerular filtrate is like plasma and has very little proteins but not fats. In glomerulopathies, there is proteinuria. The filtrate passes through the tubules and is modified by the processes of selective reabsorption and tubular secretion. In healthy persons, glomerular filtration rate (GFR) remains constant. Renal perfusion pressure and renal blood flow are regulated by alterations in the relative tone of afferent and efferent arterioles via release of renin by JGA in response to the changes in the delivery of solutes to the macula densa.

Functions of kidneys

1. Kidneys excrete waste products such as urea, creatinine and uric acid.
2. Kidneys regulate composition and volume of body fluids by adjusting the secretion of antidiuretic hormone (ADH).

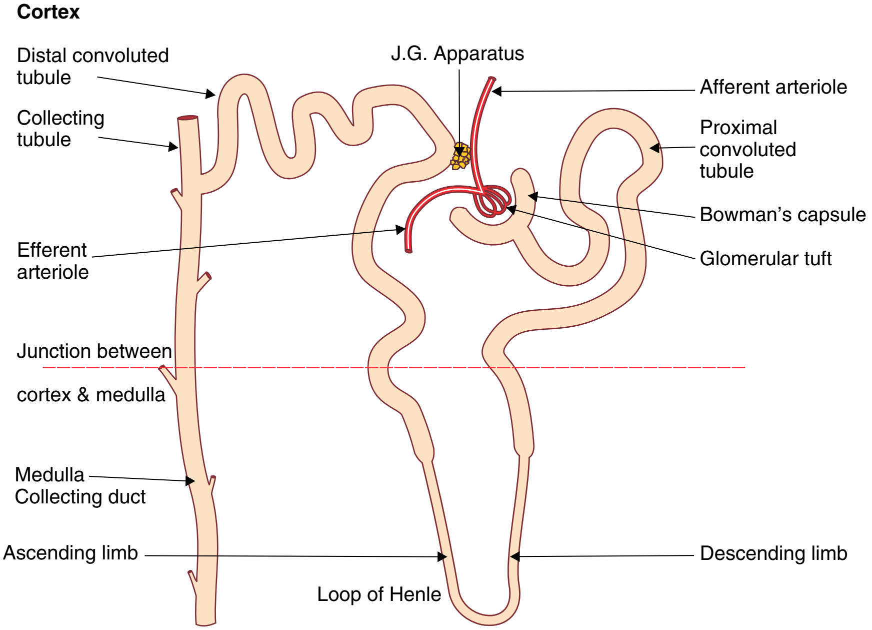

Figure 6.1 Nephron – Afferent arteriole originating from the interlobular branch of the renal artery branches into capillaries to form glomerulus tufts that then merge to form the efferent arteriole. From the glomerulus, the proximal convoluted tubule descends to form the loop of Henle at the corticomedullary junction with a narrow descending limb and an ascending limb (upper third of which is thick). Then, the nephron merges with the distal convoluted tubule, and then the cortical collecting tubule and medullary collecting duct open at the tip of the papilla.

3. By maintaining renal threshold values, kidneys retain some useful blood contents.
4. Kidneys maintain homeostasis of electrolytes (K^+, Na^+), anions and cations, minerals, and salt and water through renin-angiotensin-aldosterone system.
5. They secrete renin that converts angiotensinogen to angiotensin.
6. Hydroxylation of vitamin D3 to 1,25-dihydroxycholecalciferol takes place in kidneys. Impaired hydroxylation leads to hypocalcemia and renal osteodystrophy in chronic renal failure (CRF).
7. Erythropoietin is secreted by kidneys, which stimulates erythropoiesis.

Blood flow to kidneys is regulated as they produce vasodilators (prostaglandins) and a vasoconstrictor enzyme (kallikrein), which have an effect on blood flow. (Both are locally produced)

Symptoms of renal and urological diseases

1. **Pain** – Pain is one of the commonest symptom. It can be of renal, ureteric or bladder origin. Renal (kidney) pain is felt in the loin or the flank region. Renal pain is usually due to the stretching of the renal capsule or the renal pelvis. Pain radiates from loin to iliac fossa and to testicles or labia if it is due to ureteric stone. Once the stone enters urinary bladder, the pain disappears. Glomerulonephritis is usually a painless condition. Kidney tumor, large renal cyst or perinephric abscess cause dull, persistent flank pain.

   Bladder pain, usually due to bacterial cystitis, is felt in the suprapubic area with radiation to distal urethra during micturition. Acute retention of urine causes severe bladder pain. Chronic obstruction to bladder outflow is usually painless.
2. **Frequency of micturition** – Frequency of micturition is present with urinary tract infection, diabetes mellitus (DM), diabetes insipidus, irritation of trigone of the bladder. Excessive water intake can lead to polyuria and frequency of micturition. Decrease in the functional bladder capacity, enlarged prostate and bladder neck obstruction can cause frequent urination. In such situation, detrusor muscle contracts at relatively low bladder volume due to low functional bladder capacity. The urinary volume is small, but the desire to urinate may be almost continuous.
   a. Causes of increased frequency of micturition without an increase in urine volume
      i. Bladder infection (cystitis)
      ii. Foreign body in the bladder
      iii. Bladder stone

        - **iv.** Bladder tumor
        - **v.** Reduced bladder capacity

3. Polyuria (greater than 2500 ml/day) – It can be water or solute diuresis. Polyuria may be due to

- **a.** Excessive water drinking e.g. psychogenic polydipsia (water diuresis)
- **b.** Osmotic diuresis, secondary to glucose (DM), urea (CRF) (solute diuresis)
- **c.** Abnormal renal tubular water handling, e.g. diabetes insipidus and renal resistance to ADH – nephrogenic diabetes insipidus (water diuresis).

4. Nocturia – Nocturia is the need to urinate during sleep hours. In healthy young persons, there is hardly any need to get up during sleep hours to urinate. This is because of diurnal variation in urine formation (less during night) and adequate functional capacity of bladder. However, in conditions of polyuria and conditions with reduced functional bladder capacity, there is nocturia (DM, diabetes insipidus, enlarged prostate). Nocturia may be an early manifestation of renal disease, heart failure and liver failure.

- **a.** Causes of nocturia
    - **i.** Excessive urine output
        - Late evening fluid intake
        - Diuretics, caffeine, theophylline, alcohol
        - Edema (congestive cardiac failure [CCF], hypoproteinemia, due to drugs such as nifedipine, amlodipine)
    - **ii.** Insomnia – Due to pain, caffeine and breathlessness
    - **iii.** Bladder and lower urinary tract diseases
        - Small contracted bladder
        - Prostatic hyperplasia
        - Overflow incontinence
        - Cystitis
        - Bladder stone
        - Bladder growth
        - Extrinsic pressure (by a pelvic tumor)

Nocturia is usually pathological.

5. Oliguria/Anuria – Urine volume less than 500 ml per day is oliguria and less than 100 ml per day is anuria. Oliguria can be (1) prerenal (low fluid intake or severe fluid loss, e.g. sweating, vomiting, diarrhea) due to reduction in extracellular fluid (ECF) volume and GFR, (2) renal due to renal disease (e.g. acute glomerulonephritis, acute tubular necrosis, renal failure) and (3) postrenal due to obstructive uropathy (obstruction at any level from collecting system in the kidneys to urethra, e.g. stone, tumor, enlarged prostate).

6. Dysuria – Dysuria is the painful urination. It is commonly due to severe bacterial infection or inflammation of bladder neck or urethra. Patient experiences burning during micturition. Strangury is a severe form of dysuria where there is painful desire to urinate at the end of micturition and severe suprapubic pain.

Persistent dysuria without an evidence of infection indicates bladder neck and urethral involvement.

7. Hematuria – Hematuria (passage of blood in urine) may be painless or painful. It may be gross (seen with naked eye) or microscopic. The urine may be red to brown in color.

In renal diseases (glomerulonephritis), hematuria is painless, continuous and usually microscopic. In stones and tumors of kidney and urinary bladder, hematuria is gross and may be painful and intermittent. These patients need cystoscopy, intravenous pyelography and retrograde pyelography for exact etiological diagnosis. In women during menses, "hematuria" is invariably seen (due to contamination) (Boxes 6.1 and 6.2).

Types of hematuria (painful or painless) **Box 6.1**

1. Painful
    - Renal calculi
    - Renal papillary necrosis
    - Urinary tract infection
    - Acute renal artery embolism (renal ischemia)
2. Painless
    - Tuberculosis
    - Glomerulonephritis
    - Polycystic kidney disease
    - Hypertension
    - Schistosomiasis
    - Papilloma
    - Hypernephroma

Etiological causes of hematuria (Fig. 6.2) Box 6.2

1. Renal
   - Acute glomerulonephritis
   - Calculi
   - Tuberculosis
   - Renal infarction
   - Renal tumors (Wilms tumor, hypernephroma)
   - IgA nephropathy
   - Polycystic kidney disease
   - Renal cysts
2. Postrenal
   - Ureteric calculi, tumors
   - Bladder stones, tumors
   - Tuberculosis, bilharziasis of bladder
   - Cystitis (bacterial, radiation, chemical)
   - Enlarged prostate (benign, malignant)
   - Urethritis
   - Urethral tumors
   - Hydronephrosis
3. Systemic
   - Bleeding disorders (purpura, coagulation defects)
   - Anticoagulant therapy
   - Sickle cell trait/disease

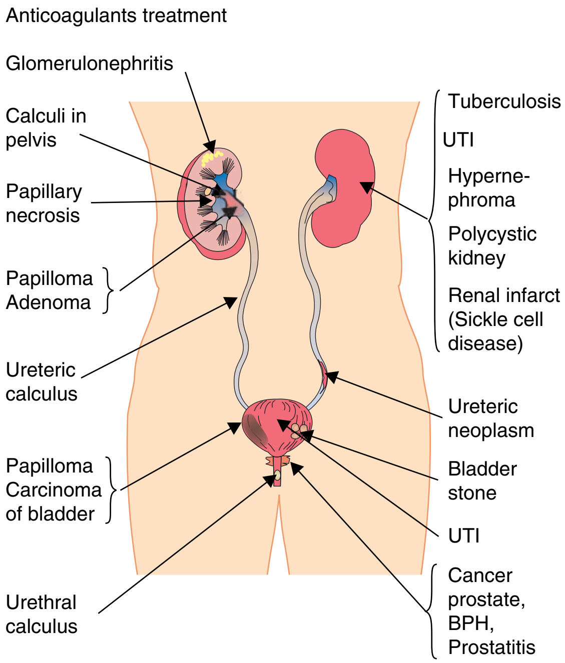
Anticoagulants treatment
Glomerulonephritis
Calculi in pelvis
Papillary necrosis
Papilloma Adenoma
Ureteric calculus
Papilloma Carcinoma of bladder
Urethral calculus
Tuberculosis
UTI
Hyperne-phroma
Polycystic kidney
Renal infarct (Sickle cell disease)
Ureteric neoplasm
Bladder stone
UTI
Cancer prostate, BPH, Prostatitis

Figure 6.2 Causes of hematuria.

8. **Chyluria** – It is the presence of lymph in urine. With obstruction to lymphatic flow, abnormal connections develop between retroperitoneal lymphatics and renal collecting system. Important causes are filariasis, lymphoma or an occult neoplasm.
9. **Pneumaturia** – It is passage of gas in the urine. It is the result of fistulous connection between urinary bladder and gastrointestinal tract and rarely due to gas formation by bacteria.
10. **Urgency and incontinence** – Urgency to urinate is initially perceived as the inability to postpone micturition beyond the time of urge to urinate. In extreme cases, it can lead to urge incontinence.
11. **Causes of urinary incontinence (loss of voluntary control)**
    - **a.** Incoordination of sphincter function, usually seen in elderly
    - **b.** Benign prostatic hypertrophy or cancer prostate
    - **c.** In women, pelvic floor damage during delivery
    - **d.** Multiple sclerosis
    - **e.** Spinal cord compression, cauda equina syndrome involving nerve supply to bladder
12. **Hesitancy of micturition, slow stream and terminal dribbling** – These three symptoms are usually seen in men with enlarged prostate. Initiation of urination is difficult (hesitancy), the stream is thin and slow and finally dribbling without clean stoppage of micturition.
13. **Complaints of patients with prostatic enlargement and bladder neck obstruction**
    - **a.** Reduced force of urine stream
    - **b.** Hesitancy of micturition
    - **c.** Postvoid dribbling
    - **d.** Nocturia
    - **e.** Retention of urine
14. **Discharge per urethra** – Gonococcal urethritis is the most common cause of purulent discharge with local pain.
15. **Urine color** – Enquire and observe
    - Concentrated urine – Deep yellow color
    - Conjugated bilirubin – Orange brown
    - Food pigments, drugs, e.g. rifampin – red, B complex – yellow

- Hematuria – Red
- Hemoglobinuria, myoglobinuria – Red–brown
- Pyuria – Yellowish
- Porphyria – Opalescent. On standing, turns red or brown
- Melanoma, alkaptonuria – Brownish black
- Precipitated urates – Red (in acidic urine)
- Amorphous phosphate salts in alkaline urine – Cloudy
- Chyluria – Milky

Menstrual and obstetric history

Enquire the age at menarche and menopause. Details of menstrual cycle including blood flow and whether accompanied with pain (dysmenorrhea) should be recorded. Also enquire about contraceptive pills or hormone replacement therapy.

Obstetric history comprises details of all pregnancies (successful pregnancies and miscarriages), problems during pregnancy, whether normal delivery or forceps, episiotomies and caesarian section. Enquire about vaginal discharge and vaginal bleeding.

Sexual history

Sexual history comprises frequency of sex, number of partners, whether heterosexual, homosexual or bisexual, whether using condom every time, problems related to sex drive, erection, ejaculation or orgasm.

Sexual dysfunction may be due to DM, alcoholism, psychological disorders and marital maladjustment. In majority of persons, loss of libido, premature ejaculation, inability to maintain an erection and failure to achieve orgasm are due to psychological problems.

General examination

1. Look for puffy face (periorbital swelling), edema feet and distension of abdomen due to ascites (a clinical picture of nephrotic syndrome), pallor and purpuric spots or bruises over skin. Nails look pale and sometimes opaque white (leukonychia) in nephritic syndrome and CRF. Occasionally, one may see splinter hemorrhages in the nails due to infective endocarditis or vasculitis.
2. Hypertension is present in acute and chronic glomerulonephritis, tubulointerstitial disease, renal stone disease, obstructive uropathy, vasculitis, lupus nephritis and renovascular hypertension.
3. Clinical features may develop due to defective salt and water handling by the kidneys leading to extra cellular fluid (ECF) expansion (hypervolemic state) or contraction (hypovolemic state).
    a. Signs of hypervolemia – In hypervolemic state, following signs may be detected:
        i. Raised JVP
        ii. Edema of legs, ascites
        iii. Crackles over lung bases, pleural effusion
        iv. Hypertension in some
    b. Signs of hypovolemia – In hypovolemic state, following features may be noticed:
        i. Loss of skin elasticity (elderly persons have poor elasticity)
        ii. Low volume pulse, low blood pressure (BP), sinus tachycardia
        iii. Flat neck veins (JVP zero)
4. Renal rickets in children suffering from CRF.
5. In severe renal failure, patients develop acidotic breathing (deep, sighing breathing – Kussmaul's breathing). In advanced renal failure, coarse tremors of hands (uremic metabolic flaps) are observed, particularly when wrists are held in front in dorsiflexed position. These are similar to liver flaps seen in liver cell failure.
6. Eyes – Corneal calcification is seen in CRF, particularly in patients with long-standing secondary hyperparathyroidism (elevated calcium and phosphorus). Limbic (corneal) calcification should not be mistaken with arcus senilis, which is a broader band at corneal edge and merges with the sclera. Arcus is usually seen along the superior and inferior margins, whereas limbic calcification is present along the medial or lateral borders of cornea.

Funduscopy is done to detect retinopathy, central retinal artery or retinal vein thrombosis.

Examination of the abdomen

- Inspection is of little help except with gross enlargement of kidney (hydronephrosis) or tumors such as hypernephroma or polycystic kidneys. In perinephric abscess, there is redness and edema of the skin overlying the abscess.
- Palpation – Kidneys are palpated bimanually (see Chapter 1). Renal angle tenderness is present with inflammation of kidneys (pyelonephritis).
- Percussion – Kidney mass or tumor is dull to percussion, but on the left side, one may elicit colonic resonance in front of the kidney

swelling, which is the differentiating point from splenomegaly.
- Auscultation – Bruit over renal arteries indicates renal artery stenosis. In uremia, one should look for pericardial or pleural rub due to uremic pericarditis and pleurisy. Their presence indicates either advanced uremia or patient having collagen disorder such as systemic lupus erythematosus (SLE), which manifests with renal and extrarenal features. There may be S3 and S4 gallop due to left ventricular failure, secondary to renovascular hypertension.

Examination of the bladder

Inspection

If distended, bladder can be seen as a pyriform swelling in the hypogastric region.

Palpation

Bladder outline can be confirmed by palpation. Its lower margin cannot be reached as it arises from the pelvis. Palpation may cause discomfort to patient and may cause urgency to urinate.

Percussion

Full bladder is dull to percussion.

For confirmation, patient is asked to evacuate the bladder or the bladder is emptied by catheterization when the bladder swelling disappears.

External genitalia

Male genitalia

Examine urethral meatus for redness, ulceration for urethritis and circinate balanitis. Patients with urethritis complain of pain while urinating. Some children may show meatal ulcer or stenosis, which may be related to circumcision for phimosis (tight foreskin over glans penis.)

Retract the prepuce and inspect glans penis and corona glandis. Look for smegma. Palpate the shaft of penis and feel for thickness of penile urethra and for any tenderness or purulent discharge from urethra. This along with tenderness of epididymis suggests gonorrheal infection. In tuberculous infection, the epididymis is enlarged, craggy and tender.

Testis and ductus deferens (vas) should be palpated gently. Normally there should be no beading of vas and there should be no tenderness of vas and testis. Hydrocele is the commonest cause of scrotal swelling and it should be differentiated from hematocele, chylocele and testicular tumor. Positive transillumination test using pen torch confirms hydrocele. Malignant tumors (teratomas) are firm to hard in consistency and tender. Orchitis is not uncommon in mumps. Testicles are swollen, firm and tender. In testicular atrophy, testes are small and are not tender to pressure. Syphilis can cause loss of testicular sensation.

Causes of ulcerative lesions of glans penis

- Primary syphilitic chancre
- Reactive arthritis – Circinate balanitis
- Herpes
- Candida
- Stevens–Johnson syndrome
- Behcet's disease

Female genitalia

Infection of vulva and vagina (vulvovaginitis) is fairly common particularly in patients with diabetes and elderly women. The common infections are monilial, trichomonal and gonococcal. Patients complain of local itching and burning pain while passing urine. Patient may have cystocele causing stress incontinence (if small in size) and retention of urine (if large in size). Pruritus vulvae is commonly seen in patients with diabetes and elderly women due to dryness and fungal infection.

Per rectum examination (PR examination)

Per rectal examination is necessary in patients with urinary symptoms suggesting prostate enlargement (see Chapter 1). Normal consistency of prostate is rubbery and surface is smooth. Hard or nodular feel with or without tenderness should raise suspicion of malignancy. In prostatitis, there is tenderness. It is difficult to palpate seminal vesicles as these lie above the prostate running upwards from its outer margins. In tuberculous infection, seminal vesicles are thickened.

Urine examination

To complete clinical examination, urine should be examined for color, specific gravity, proteinuria, glycosuria, red blood cells, pus cells, casts, crystals and microorganisms.

CLINICAL CASES

A case of nephrotic syndrome

1. **Introduction** – Nephrotic syndrome is characterized by generalized edema, puffiness of face, pallor, hypoalbuminemia (serum albumin less than 3 g/100 dl), albuminuria (greater than 3.5 g/day) and hypercholesterolemia (serum cholesterol greater than 300 mg/dl).
2. **Etiopathology**
   - a. Glomerular disease – Majority (75%) are due to glomerular pathology
     - i. Minimal change glomerulonephritis (most common, 90% in children)
     - ii. Membranous glomerulonephritis
     - iii. Membranoproliferative glomerulonephritis
     - iv. Mesangioproliferative glomerulonephritis
     - v. Focal glomerulosclerosis
   - b. Systemic causes (25%)
     - i. Infections (malaria, syphilis, infective endocarditis, HIV, HBV)
     - ii. Metabolic – DM
     - iii. Systemic collagen disorders (SLE)
     - iv. Drug toxicity (gold, NSAIDs, penicillamine, rifampicin)
     - v. Malignancy (lymphoma, Hodgkin's disease, leukemias)
     - vi. Hypersensitivity reactions
     - vii. Heredofamilial diseases (e.g. Alport's syndrome)
     - viii. Amyloidosis
   - c. Idiopathic
3. **Clinical features** – As minimal change disease is the commonest cause, nephrotic syndrome is commonly seen in children and adolescents (Fig. 6.3). The onset is insidious with development of anasarca. Puffiness of face, pallor, bloated abdomen, swollen scrotum and legs is the presenting picture (Fig. 6.4). BP is normal. Proteinuria (24 hours albumin greater than 3.5 g), hypoalbuminemia (serum albumin less than 3 g/100 dl), low Hb, hypercholesterolemia are characteristic laboratory findings. Kidney biopsy is useful to diagnose the type of glomerular lesion.
4. **Prognosis** – Patients with minimal change disease have a better prognosis than those with

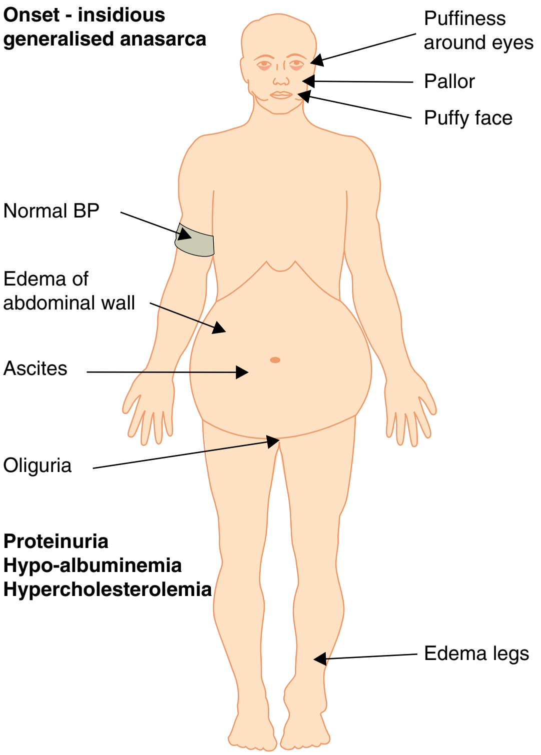
Onset - insidious
generalised anasarca
Puffiness around eyes
Pallor
Puffy face
Normal BP
Edema of abdominal wall
Ascites
Oliguria
Proteinuria
Hypo-albuminemia
Hypercholesterolemia
Edema legs

Figure 6.3 Salient clinical features of nephrotic syndrome.

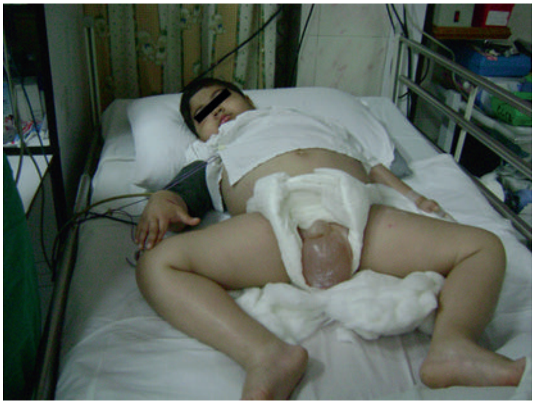

Figure 6.4 Nephrotic syndrome showing generalized anasarca.

other glomerular pathologies. Diabetic nephropathy develops in long-standing cases of uncontrolled DM. It is the result of microangiopathy and is associated with retinopathy and neuropathy. Patient develops proteinuria, hypoproteinemia, hypertension, nephrotic syndrome and finally renal failure within 4–5 years. For assessment of nephrotic syndrome, 24 hours urinary albumin, severity of hypoalbuminemia, hypercholesterolemia, complement levels, presence of DM, collagen disorders (SLE), the type of glomerular lesion (by renal biopsy) have to be determined and the underlying malignancy or renal vein thrombosis has to be excluded.

5. **Management**
   a. Bed rest
   b. Diet – Allow proteins according to the severity of glomerular damage (GFR). If GFR is normal (greater than 60 ml/minute), there is no restriction of proteins and if GFR is less than 60 ml/minute, protein intake is restricted to 0.8 g/kg/day + 1 g protein/g proteinuria.
   c. Diuretics to relieve edema
   d. With gross anasarca, salt-free albumin infusions are to be considered
   e. Treat the underlying cause. In DM, good control along with ACE inhibitors (with careful monitoring of serum K levels) is essential.
6. **Complications**
   a. Infections (peritonitis, pneumonia)
   b. Atherosclerosis, xanthoma (due to hypercholesterolemia)
   c. Deep venous thrombosis and pulmonary embolism
   d. Renal failure

A case of acute renal failure

1. **Introduction** – There is rapid worsening of renal functions, with rise in blood urea nitrogen, serum creatinine and serum K^+. GFR declines rapidly and there are disturbances of electrolytes and acid–base balance. Approximately 50% of patients develop oliguria or anuria.
2. **Classification**
   a. Prerenal acute renal failure (ARF) – The perfusion of kidneys is compromised, resulting in decrease of GFR. Common causes are heart failure, myocardial infarction, hypovolemia due to gastroenteritis, hemorrhage, vasodilation due to sepsis, anaphylactic shock, renal hypoperfusion due to renal artery stenosis and NSAIDs.
   b. Renal ARF – Causes are acute progressive glomerulonephritis, acute tubular necrosis due to toxins or ischemia, acute interstitial nephritis due to infections, vasculitis, hypotension, drugs (aminoglycosides, NSAIDs), contrast dyes and rhabdomyolysis.
   c. Postrenal ARF – Causes are obstruction to the urinary tract caused by renal, ureteric or bladder calculi; papillary necrosis; enlarged prostate; tumors of renal pelvis, ureter and bladder; bladder neck obstruction; urethral obstruction (enlarged prostate commonest cause); retroperitoneal fibrosis or neoplasm.
3. **Clinical presentation** – In patients with prerenal failure, there is hypotension and features of poor peripheral perfusion, which lead to renal vasoconstriction and prerenal ARF. The cause of inadequate circulation may be obvious or not clear due to concealed hemorrhage in the gastrointestinal tract or uterine bleeding or following crush injuries. Diagnosis is confirmed when renal function improves after replacement of fluid volume by blood or colloids.

   Renal cause of ARF can be confirmed by kidney biopsy. Proteinuria and urinary casts indicate renal cause of ARF. With interstitial nephritis, patient may present with fever, skin rashes and "pus" cells in urine.

   Distended bladder, enlarged prostate and hydronephrosis suggest postrenal cause of ARF.

   In ARF, oliguria lasts for 1–2 weeks. Blood urea and serum creatinine rise.

   During recovery, the urine output improves day by day. The levels of blood urea and serum creatinine gradually decrease and return to normal within 1–2 weeks.
4. **Treatment of ARF** – With the help of history, physical examination and investigations, determine the cause of ARF (prerenal, renal or postrenal) and treat the cause. For prerenal ARF, give intravenous fluids or intravenous

furosemide (40–120 mg) to improve urine output. Maintain strict intake and output chart. Adjust the dose or stop nephrotoxic antibiotics and drugs such as ramipril. Avoid NSAIDs and other nephrotoxic drugs.

With renal cause, restrict daily fluid intake according to urine output during the previous day. Avoid fruits, fruit juices and coconut water. Severe hyperkalemia, elevated serum creatinine and blood urea nitrogen and acidosis are indications for dialysis.

Indications for dialysis

- **i.** Serum creatinine greater than 6 mg/dl
- **ii.** Serum potassium greater than 6 mEq/l
- **iii.** Blood urea greater than 250 mg/dl
- **iv.** Acidosis (pH less than 7.0)
- **v.** Fluid overload not responding to diuretics
- **vi.** Presence of pericarditis, cardiac tamponade and pulmonary edema unresponsive to diuretics

A case of chronic renal failure

1. **Introduction** – CRF sets in when there is significant and permanent reduction of GFR. This progresses to uremia when end products of nitrogen metabolism rise. It proves fatal unless dialysis or renal transplant is performed.
2. **Etiopathology** – Causes of chronic failure are given in Table 6.1
3. **Clinical features** (Fig. 6.5)
   - **a.** Stages of CRF
     - **i.** Stage 1 – Normal GFR (greater than 90 ml/minute/1.73 m^2 BSA) Body surface area
     - **ii.** Stage 2 – GFR of 60–90 ml/minute/1.73 m^2
     - **iii.** Stage 3 – GFR of 30–59 ml/minute/1.73 m^2
     - **iv.** Stage 4 – GFR of 15–29 ml/minute/1.73 m^2
     - **v.** Stage 5 – GFR less than 15 ml/minute/1.73 m^2

Albuminuria of varying severity is present in all stages.

Serum creatinine is widely used as a marker for GFR, and the GFR is related directly to the urine creatinine excretion and inversely to the serum creatinine (Ucr/Pcr). Creatinine clearance and GFR are calculated as per the formula given below.

Table 6.1 Causes of chronic renal failure

Glomerulonephritis	Proliferative, membranoproliferative, crescentic
Obstructive	Renal calculi, enlarged prostate, renal tumor, retroperitoneal fibrosis
Vascular	Accelerated hypertension, renovascular vasculitis (PAN, SLE, WG, MPA)
Metabolic diseases	DM, amyloidosis, gout
Interstitial	Chronic interstitial nephritis, analgesic nephropathy, chronic pyelonephritis, tuberculous pyelonephropathy
Congenital	Polycystic kidney, cystic medullary necrosis, Alport's syndrome

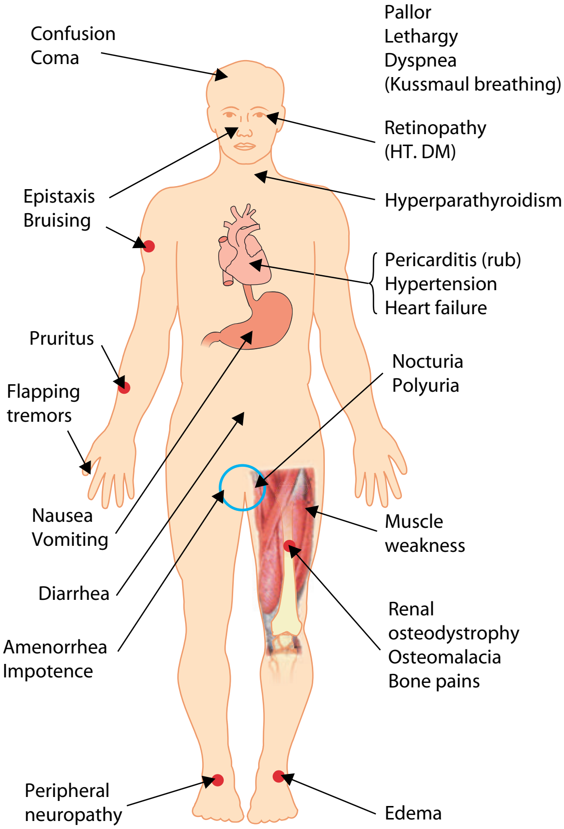
Confusion
Coma
Pallor
Lethargy
Dyspnea
(Kussmaul breathing)
Retinopathy
(HT. DM)
Epistaxis
Bruising
Hyperparathyroidism
Pericarditis (rub)
Hypertension
Heart failure
Pruritus
Nocturia
Polyuria
Flapping
tremors
Nausea
Vomiting
Muscle
weakness
Diarrhea
Renal
osteodystrophy
Osteomalacia
Bone pains
Amenorrhea
Impotence
Peripheral
neuropathy
Edema

Figure 6.5 Clinical features of chronic renal failure.

Creatinine clearance (ml/minute)

$$= \frac{(140 - \text{age}) \times \text{lean body wt (kg)}}{\text{plasma creatinine (mg/dl)} \times 72}$$

For women, multiply the calculated value by 0.85 **(Cockroft Gault Equation)**.

$$\text{GFR}\left(\text{ml/ min per } 1.73\text{m}^2\right)$$
$$= 186.3 \times \text{Pcr}\left(e^{-1.154}\right) \times \text{age}\left(e^{-0.203}\right)$$

(MDRC Equation)

In outpatient-department setting, the serum creatinine is often used as the surrogate for GFR (although it is less accurate).

In general, patients do not develop symptomatic uremia until renal insufficiency is quite severe (GFR less than 15 ml/minute).

4. Clinical manifestations of uremia

- Nausea, vomiting, furred tongue
- Altered mental state (drowsiness, coma)
- Flapping tremors, irritability, convulsions, fasciculations
- Kussmaul breathing, hiccoughs, uremic breath
- Weakness, weight loss
- Hypertension, cardiomegaly, CCF, pericarditis, pericardial rub
- Scratch marks, uremic frost, bruising, calcium deposits in skin (in patients on dialysis), hyperpigmentation of skin, dry skin, pallor and tetany may be seen
- Periorbital edema, band keratopathy
- Pitting edema of legs
- Nails – Distal brown (Lindsay lines)
- Palpable kidneys – Bilateral – polycystic kidneys, hydronephrosis; Unilateral – unilateral hydronephrosis)
- Muscle weakness, peripheral neuropathy
- Stunted growth in children
- Bone tenderness
- Peripheral neuropathy
- Fundus – Retinopathy (HT, DM)

The cause of uremia should be determined during clinical examination

- Skin rash (drug hypersensitivity)
- Hemoptysis (vasculitis)
- Splinter hemorrhages, splenomegaly infective endocarditis
- Icterus (Weil's disease, mismatch transfusion presenting mostly as ARF)
- Tophi (gout)
- Nail patella syndrome
- Distended bladder (bladder neck obstruction)
- Abdominal bruit (renal artery stenosis)

Finally look for

- Arteriovenous fistula for hemodialysis
- Abdominal scars of previous surgery, particularly renal transplant

5. Investigations

a. Urine examination

b. Blood urea, blood urea nitrogen, serum creatinine

c. Ultrasound of abdomen, KUB to assess the size of kidneys. In CRF, both the kidneys are small and contracted (less than 8 cm in length)

Note – CRF with enlarged but poorly functioning kidneys is seen with polycystic kidneys, amyloidosis, some cases of DM, myeloma kidney and bilateral hydronephrosis.

6. Management

a. In obstructive uropathy, treat the obstruction, e.g. stones, enlarged prostate, stricture urethra and bladder neck obstruction

b. Treat and control hypertension

c. Treat anemia with erythropoietin

d. Diet (see Chapter 14)

i. Proteins

- Normal GFR (greater than 60) – No restriction (1 g/kg/day)
- Low GFR (less than 60) – Restrict to 0.6 g/day with at least 50% protein of high biological value

ii. Sodium – Restricted to 4–6 g depending upon edema and hypertension

iii. Potassium – Avoid potassium rich drinks (coconut water, fruit juices)

iv. Water – Restrict fluids (less than 1 l/day) in presence of edema.

e. Treat edema with diuretics (high furosemide doses – up to 250 mg, intravenous daily)

f. Treat renal bone disease with calcium carbonate (300–1200 mg tds) and alfacalcidol (0.25–1 mg daily) orally

g. Symptomatic treatment of hiccups with chlorpromazine 25 mg tds

h. Hemodialysis

i. Renal transplant

A case of polycystic kidney disease

1. Introduction – It is a genetic disorder of kidneys, which may be associated with polycystic liver disease. Adult polycystic kidney disease,

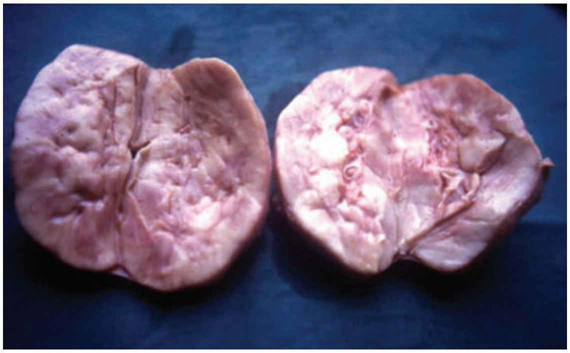

Figure 6.6 Pathological specimen of polycystic kidney.

which is more common, is inherited as an autosomal dominant trait with equal male and female prevalence. The cysts that are small initially appear during infancy, but as age advances, the cysts enlarge and kidneys enlarge asymmetrically (Fig. 6.6). The rare type of infantile polycystic kidney, which is inherited as an autosomal recessive character, is usually fatal in the first year of life.

2. **Clinical features** – The disease may remain asymptomatic for a long time. The onset is insidious with presentation as hypertension in young adults. Kidney functions are well preserved for a long time. Other clinical features are pain, heaviness and vague discomfort in loins due to enlarged kidneys. Some patients present with hematuria or urinary tract infection or even renal failure. On physical examination, one or both the kidneys may be palpable and tender. BP is raised. In approximately 30% of cases, hepatomegaly due to cysts may be detected. The patients may have associated berry aneurysms in cerebral blood vessels resulting in subarachnoid hemorrhage in few cases. Overall prognosis is fair, but with passage of time, renal failure sets in.
3. **Investigations**
    - **a.** Routine urine examination
    - **b.** Renal functions (blood urea, serum creatinine)
    - **c.** Ultrasound of abdomen to confirm the diagnosis
    - **d.** In few cases, CT abdomen may be required for confirmation
4. **Management**
    - **a.** Control hypertension
    - **b.** Treat urinary tract infection
    - **c.** Management of renal failure

Since now the gene defect is known, first-degree relatives of patients should be screened at young age with ultrasound and the patients must be counseled before they start their family.

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Chapter 7

Endocrine and metabolic diseases

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INTRODUCTION AND BASIC CONSIDERATIONS

This chapter covers the following important endocrine glands

- Pituitary
- Thyroid
- Parathyroid
- Adrenals
- Pancreatic islet cells

Hormones secreted by these endocrine glands are responsible for

- Growth and development of body
- Control of protein, carbohydrate and fat metabolism
- Control of water, electrolyte and mineral metabolism
- Development of sex organs, secondary sex characters and control of reproductive function
- Helping body to face and adapt to stressful situations

Among the endocrine glands, pituitary gland is the master gland as it secretes trophic hormones – growth hormone (GH), thyrotrophic-stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), follicle-stimulating hormone (FSH), luteinizing hormone (LH) and prolactin (PRL). Pituitary gland in turn is controlled by hypothalamus which secretes hormones controlling release of each trophic hormone. Trophic hormones stimulate the target organs such as thyroid, adrenals, gonads (testes and ovaries) and breasts (Fig. 7.1).

To regulate the above stimulating chain from hypothalamus to pituitary gland and then to target glands, there is a reverse feedback system which has an inhibitory effect, e.g. thyroxine inhibiting TSH and that in its turn inhibiting thyrotrophin-releasing hormone (TRH). The end result is a physiological balance between stimulating and negative feedback systems to maintain euthyroid state in healthy individuals (Fig. 7.2).

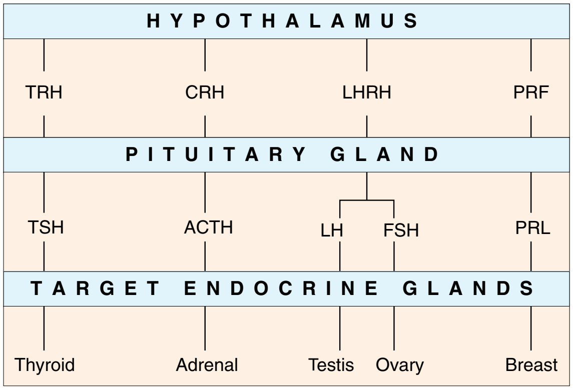

Figure 7.1 Control of important endocrine glands.

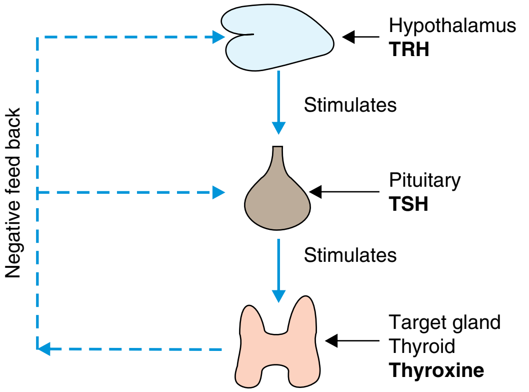

Figure 7.2 Negative feedback system.

CLINICAL PRESENTATION

Diseases of endocrine glands may remain undiagnosed for a variable period of months or years.

The most common endocrine disorder is diabetes mellitus (DM) which may be undiagnosed till the patient is in prediabetic stage or stage of impaired glucose tolerance (IGT). Such cases are detected while undergoing health check up with glucose tolerance test or 2 hours postglucose levels. Even during prediabetic stage, patient is at risk as endothelial cell dysfunction has already commenced.

Another common endocrine disorder seen in practice is hyper or hypothyroidism. Idiopathic hypothyroidism in middle-aged persons (particularly women) remains undiagnosed for long periods. Physician has to keep these conditions in mind and investigate such cases to confirm the diagnosis.

Subclinical hypothyroidism is diagnosed in patients with elevated TSH, normal free T4 and absent or minimal symptoms of hypothyroidism.

Complaint of impotence should not be neglected and be attributed to aging. It could be a symptom of hyperprolactinemia in men. Hence, in such cases, ask for PRL levels. In women, prolactinemia causes oligomenorrhea, galactorrhea and infertility.

It is common for patients with endocrine disorders to present with symptoms related to other systems. For example, patients with hyperthyroidism and pheochromocytoma present with arrhythmias to a cardiologist or patients with Addison's disease and thyroid disorders present with pigmentation and itching, respectively, to a dermatologist. Patients with endocrine disorders may present with any of the following complaints.

a. **Polyuria, polydipsia and polyphagia** – These symptoms are classically seen in DM but polyuria and polydipsia are common symptoms. Only polyuria and polydipsia are seen in diabetes insipidus due to deficiency of antidiuretic hormone (ADH) or failure of ADH to act on renal tubules (nephrogenic diabetes insipidus). Some patients suffer from psychogenic polydipsia (compulsive water drinking) and have polyuria. It is very important to differentiate diabetes insipidus from psychogenic polydipsia in which usually there is no polyuria during sleep. In contrast to diabetes insipidus, urine concentrating capacity is preserved in psychogenic polydipsia.

Uncommon causes of polyuria and polydipsia are hyperparathyroidism and Conn's syndrome.

b. **Weight gain**
   - Obesity is usually due to overeating and sedentary lifestyle. It is usually familial. It may be associated with Type II DM as a symptom complex of metabolic syndrome.
   - In Cushing's syndrome, obesity is mainly truncal involving interscapular, abdominal and omental fat with thinning of extremities.
   - In primary hypothyroidism, patient puts on weight due to myxomatous deposition and there is nonpitting edema.
   - Weight gain is one of the manifestations of hypothalamic lesions. It is characteristic of adiposogenital syndrome and leptin deficiency (very rare cause).

c. **Weight loss**
   - Hyperthyroidism – Patient looses weight due to increased metabolic rate. Appetite is good. In elderly patients, it may mimic malignant disease as they have loss of weight as well as appetite
   - Juvenile DM (insulin-dependent DM [IDDM]) – There is weight loss but appetite is good
   - Addison's disease
   - Hypopituitarism
   - Anorexia nervosa

d. **Palpitations** – It is a feature of hyperthyroidism, pheochromocytoma and Conn's syndrome. It is important to rule out anxiety state.

e. **Tremors** – There are fine tremors of fingers in thyrotoxicosis. These should be differentiated from slightly coarse tremors of anxiety, pill-rolling coarse tremors of Parkinson's and action tremors of cerebellar disease.

f. **Excessive sweating**
   - Hyperthyroidism (warm and moist hands)
   - Anxiety (cold and moist hands)
   - Acromegaly (hypertrophy of sweat glands)
   - Pheochromocytoma (excess of catecholamines causes excessive sweating)
   - Familial or idiopathic

g. **Cold and heat intolerance** – Cold intolerance is a typical feature of hypothyroidism while heat intolerance is seen in hyperthyroidism and menopausal syndrome.

h. **Proximal muscle (hip-girdle) weakness** – It is seen in hyperthyroidism, hypothyroidism, Cushing's syndrome, Conn's syndrome, steroid therapy, hyperparathyroidism, hypogonadism, acromegaly, vitamin D deficiency and osteomalacia. There is symmetrical proximal muscle weakness involving shoulder and hip girdle muscles (hip girdle muscle weakness is more than shoulder girdle muscle weakness). Patients find it difficult to rise from squatting position or while climbing stairs. Metabolic myopathy of vitamin D deficiency and osteomalacia is usually painful due to bone involvement.

i. **Visual symptoms** – Pituitary tumors with suprasellar extension cause bitemporal hemianopia due to compression of optic chiasma. Severe cases of thyrotoxicosis may have diplopia on lateral or upward gaze due to tethering of medial or lateral recti (exophthalmic ophthalmoplegia).

j. **Prominence of eyes** – Seen in Grave's disease.

k. **Headache** – Present in acromegaly, tumors of pituitary gland and pheochromocytoma.

l. **Depression** – Present in myxedema.

m. **Generalized weakness** – Present in DM, Addison's disease, Cushing's syndrome and hypogonadism.

n. **Renal colic due to stones** – Present in hyperparathyroidism.

o. **Rough thick skin, rough hair and falling of hair** – Seen in myxedema and acromegaly.

p. **Hypoglycemia** – Spontaneous or fasting hypoglycemia (presenting as episodic tachycardia, sweating, tremors) may occur in following conditions.
   - Insulinoma
   - Overdosage of insulin or oral hypoglycemic drugs or missing a meal
   - Addison's disease
   - Hypopituitarism
   - Severe hepatic failure
   - Mesothelial tumors (thoracic or retroperitoneal) – Secrete proinsulin-like growth factor II

q. **Paresthesias** – Paresthesias are present in hypoparathyroidism where the level of ionized calcium in the blood is low. In practice, it is more often seen in hyperventilatory states (respiratory alkalosis) and in hypokalemia (metabolic alkalosis) due to decrease in the level of ionized calcium in the blood.

r. **Difficulty in swallowing** – It occurs in nodular thyroid goiter, particularly with retrosternal extension causing pressure over esophagus. Pressure over trachea causes stridor.

s. **Local pain and tenderness in neck** – In viral thyroiditis or autoimmune thyroiditis, patient complains of pain and swelling in the neck accompanied with fever. There is localized tenderness. The differential diagnosis is from inflammatory lymph node enlargement where the pain and swelling are in the anterior triangle of neck and not in the midline as in case of thyroid swelling.

t. **Gynecomastia** – Puberty gynecomastia is not uncommon. It may disappear or persist for some years. It is usually tender. (For causes of gynecomastia, see Box 1.14.)

u. **Galactorrhea** – Seen in hyperprolactinemia (due to pituitary tumor) and hypothyroidism.

v. **Loss of libido (impotence) (erectile dysfunction)** – In significant number of cases, erectile dysfunction is due to psychological factors. However, total erectile failure and the absence of nocturnal and morning erections suggest an organic cause. In patients with diabetes, impotence may be due to associated autonomic neuropathy in addition to other causes (Box 7.1).

The causes of impotence are **Box 7.1**

- Testicular deficiency (primary testicular failure, hypopituitarism)
- Autonomic neuropathy complicating DM
- Hyperprolactinemia
- In elderly persons with atherosclerosis of penile artery resulting in decreased blood supply
- Antihypertensive drugs (a side effect)
- Psychological

w. **Amenorrhea/oligomenorrhea** – Seen in menopause, polycystic ovarian syndrome, premature ovarian failure, hyperthyroidism and Cushing's syndrome.

x. **Hirsutism** – Excessive growth of hair over face and body in women due to increased androgens is common. Mild forms are usually normal (See Box 1.8 and Fig. 1.16). Presence of hirsutism in women or hair loss of male pattern should prompt investigation of virilization.

y. **Skin manifestations of endocrine disorders** – Vitiligo is common in thyroid disorders, particularly in autoimmune hypothyroidism. In addition in hypothyroidism, skin is dry and rough, hair is coarse and there is history of hair fall from scalp and eyebrows (lateral part). In hyperthyroidism, skin is warm and palms may be moist due to sweating. In panhypopituitarism, skin is pale. In Cushing's syndrome, skin is greasy due to excessive sebum formation, and acne are seen not only on face but also over shoulders. In Addison's disease, pigmentation is seen not only over skin (particularly over creases of palms and knuckles of fingers) but also of mucous membrane (seen over tongue, oral mucosa, conjunctiva beneath the eyelids). Bluish striae on the abdomen are seen in Cushing's syndrome; necrobiosis lipoidica diabeticorum over anterior tibial region; xanthelasma over the eyelids and xanthoma over olecranon, tendo Achilles and patellar tendon are seen in DM and myxedema. These may be or may not be associated with hypercholesterolemia.

z. **Gastrointestinal symptoms in endocrine disorders** – Constipation is a feature of hypothyroidism while diarrhea may be a feature of hyperthyroidism. In DM with autonomic neuropathy, nocturnal diarrhea is common. Zollinger–Ellison syndrome presents with gastric ulceration due to hyperacidity resulting from gastrin-secreting tumor or diarrhea in some.

Patients with endocrine disorders may present with symptoms of one endocrine gland or multiple glands (pluriglandular syndrome). Hence in history of present illness, analyse various symptoms in chronological order. Also enquire regarding the use of oral contraceptive pills and hormone replacement therapy. In women, detailed obstetric history is very important. In children with stunted growth, details regarding delivery and milestones are helpful. Also, height of parents should be enquired. Details of previous surgeries (if any), particularly of thyroid, radioactive iodine therapy, chemotherapy and radiation therapy, should also be noted. Family history of DM, hypertension, endocrine disorders, height and weight of parents and siblings is very useful. In patients presenting with thyroid goiter, enquire whether patient hails from goiter prevalent area and also enquire regarding salt and iodine intake in the diet. Whether iodized salt is being used.

GENERAL EXAMINATION

Observe the build and nourishment, record height (ht) and weight (wt), and calculate body mass index (BMI) using the formula

$$\text{BMI} = \frac{\text{wt in kg}}{\text{ht(m)}^2}.$$

Normal adult male should have a BMI of 20–25 and adult female of 18–24. BMI of 26–30 is overweight, and BMI above 30 is obese (see Fig. 1.11). (For causes of tall and short statures, see Box 1.4.) One should also note the distribution of fat. Truncal obesity (abdomen, interscapular and thyrocervical regions) with sparing of extremities is classically seen in Cushing's and adiposogenital syndromes. Patients with Cushing's syndrome have plethoric moon face, while acromegalics have classical coarse features with thick lips, thick tongue, prominent cheek bones (zygoma), prominent orbital ridges, protrusion of mandible (prognathism) and coarse thick hair. The hands are thick and stubby (spade like). In myxedema, patient has periorbital puffiness (see Fig. 1.3), rough dry skin and coarse hair. In thyrotoxicosis, patient has a scared and anxious look with prominent eyeballs (see Fig. 1.18).

Observe and record the height, span, sitting height and leg length (from top of pubic symphysis to ground). In patients with Marfan's syndrome and eunuchoidism (hypogonadism), the leg length exceeds the sitting height (pubic symphysis to head) and span exceeds the total height (ground to head; see Fig. 1.9).

In Turner's syndrome (karyotype 45X0), which is characterized by gonadal dysgenesis, the patient has short stature, absence of secondary sex characters, poor or absent secondary sexual hair, wide carrying angle, low posterior hairline and prominent skinfold between the neck and the shoulder (webbing of neck).

Skin – Skin lesions can give a clue to endocrinologic diagnosis (described above).

Hair – Examination of hair can also give a clue to endocrinologic diagnosis

- Thinning – Cushing's syndrome
- Coarse – Hypothyroidism
- Hirsutism – Adrenal tumors, Cushing's syndrome, congenital adrenal hyperplasia, polycystic ovarian syndrome, arrhenoblastoma, familial, racial, idiopathic, drugs (e.g. minoxidil) and corticosteroids.
- Lack of hair – Hypogonadism

Acne vulgaris

- Contraceptive pills
- Cushing's syndrome

Face

- Pallor – Panhypopituitarism
- Vitiligo (localized) – Associated with autoimmune diseases
- Chloasma – Oral contraceptive pills
- Plethora – Cushing's syndrome, carcinoid syndrome
- Yellowish tinge – Hypothyroidism
- Easy flushing – Carcinoid syndrome, menopause

Facial appearance

- Acromegaly – Prognathism, prominent eyebrows (thick supraorbital ridges)
- Hyperthyroidism – Anxious, staring look, exophthalmos, sweating
- Hypothyroidism – Puffy face (baggy eyelids), coarse features, coarse dry hair
- Cushing's syndrome – Round moon face
- Addison's disease – Hyperpigmentation (see Fig. 1.24)

Extremities

- Large hands – Acromegaly (spade like), obesity, hypothyroidism, manual workers
- Sweaty palms – Hyperthyroidism
- Short 4th and 5th metacarpals – Pseudohypoparathyroidism
- Acropachy – DM, hypothyroidism
- Swelling of legs – Hypothyroidism
- Carpal tunnel syndrome – Hypothyroidism, acromegaly
- Necrobiosis lipoidica diabeticorum – DM
- Pretibial myxedema – Hyperthyroidism
- Proximal muscle weakness/wasting – Osteomalacia, hypo/hyperthyroidism, Cushing's syndrome, diabetic amyotrophy
- Neuropathy, ulceration, gangrene of feet – DM

Eye abnormalities

- Exophthalmos (proptosis) can be measured using an exophthalmometer. It is usually bilateral though severity of exophthalmos may be different in the two eyes. In severe cases, there may be ocular muscle paralysis, particularly involving inferior and medial recti (ophthalmoplegia).

- Lid lag and lid retraction in Grave's disease are due to increased activity of sympathetic supply to levator palpebrae superioris.
- Periorbital and lid edemas are seen in myxedema.
- Xanthelasmas are associated with DM, myxedema and hyperlipidemia (See Fig. 3.4).
- Arcus senilis is seen in the young patients with hypercholesterolemia (See Fig. 3.5).
- Visual acuity and visual field loss may be seen in hypothalamic and pituitary tumors causing pressure on optic chiasma or optic nerve. On funduscopy, one may detect pallor of disc suggesting optic atrophy (Fig. 7.3).
- Diabetic retinopathy (exudative and hemorrhagic retinopathies or proliferative retinopathy).
- Corneal calcification, which looks like a band on medial or lateral border of cornea (band keratopathy), is seen in long-standing cases of hyperparathyroidism having hypercalcemia.
- Premature cataract develops in hypoparathyroidism, hyperthyroidism, DM and steroid therapy.
- Glaucoma – Steroid therapy.

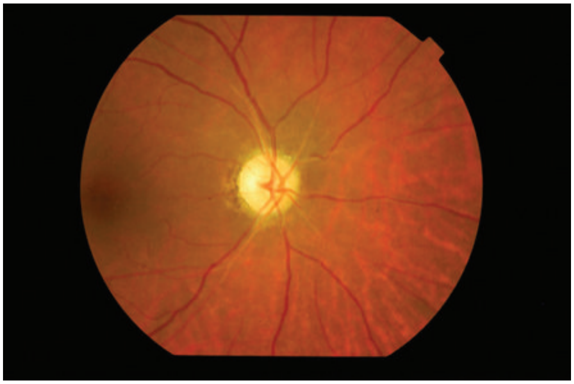

Figure 7.3 Optic atrophy.

Neck examination

- Webbing – Turner's syndrome
- Goiter – Thyroid disease (see below for details)
- Buffalo hump – Cushing's syndrome, prolonged steroid therapy
- Scars – Thyroid, parathyroid surgery
- Vitiligo – Autoimmune thyroid disorder
- Acanthosis nigricans – DM (insulin resistance)

Examination of thyroid swelling

Inspection – Examine neck from the front and from the sides to assess the size and extent of thyroid swelling. Assess whether it is diffuse, symmetrical or whether one lobe is enlarged more than the other and whether it is solitary nodule or multinodular. Ask the patient to swallow and see if the thyroid swelling is moving with deglutition or ask the patient to hyperextend the neck (Pizzalo's method), when mild swelling becomes more prominent.

Palpation – Thyroid gland is better palpated with the physician standing behind the patient with his fingers encircling the neck. Try and feel laryngeal cartilage, just below the cricoid cartilage and the isthmus of thyroid gland. Ask patient to swallow and feel with fingers the isthmus moving up. Displace the thyroid with fingers of one hand to the other side to palpate one lateral lobe and repeat the same maneuver on the other side to palpate the other lobe. Ascertain whether the enlarged gland is smooth and diffuse or lobulated; soft, firm or hard; mobile or adherent; tender. Look for palpable thrill (due to increased vascularity as seen in hyperthyroidism – Grave's disease). Ascertain the lower limit of thyroid. One cannot reach the lower limit with retrosternal extension. Using the fingers of right hand, palpate both the lobes and the isthmus from the front.

In case of multinodular goiter, feel each nodule carefully and ascertain if the thyroid enlargement is extending behind the sternum (retrosternal goiter). Also check whether the patient has features of local compression over esophagus (dysphagia), recurrent laryngeal nerve (hoarseness), trachea (stridor) and sympathetic fibers (Horner's syndrome). Also confirm whether nodule is suggestive of simple cyst, adenoma or carcinoma and whether it is firm or hard. In retrosternal goiter, neck veins and veins over upper thorax are visible and distended. This is enhanced by asking the patient to raise both arms over the head which results in compression of veins by the goiter at the thoracic inlet.

Note

- Consistency of thyroid swelling – Soft (Grave's disease), hard (cancer) and firm (Hashimoto's thyroiditis).
- Tender (thyroiditis, malignancy).
- Warm to feel (Grave's disease).
- Measurement of girth of neck at prominent point of goiter periodically while patient

is under treatment, allows assessment of improvement in size of the goiter.

Auscultation – Auscultate over lateral lobes of thyroid for a bruit (systolic bruit heard in hyperthyroidism).

Cardiovascular abnormalities

- Hypertension – Thyrotoxicosis, hyperthyroidism, diabetic amyotrophy, osteomalacia. Cushing's syndrome, Conn's syndrome, pheochromocytoma, acromegaly, myxedema
- Hypotension – Addison's disease
- Postural hypotension – Diabetes with autonomic neuropathy
- Bounding (water-hammer pulse) – Hyperthyroidism
- Arrhythmias (sinus tachycardia, atrial fibrillation) – Hyperthyroidism
- Sinus bradycardia – Myxedema

Neurological abnormalities in endocrine disorders

- Fine tremors of fingers and tongue – Hyperthyroidism
- Proximal (limb girdle myopathy) – Cushing's syndrome, thyrotoxicosis, hypothyroidism and diabetic amyotrophy
- Positive Chvostek's and Trousseau's signs – Hypoparathyroidism due to hypocalcemia causing neural excitability
- Hung up deep tendon reflexes (relaxation time is prolonged) – Hypothyroidism
- Brisk tendon reflexes – Hyperthyroidism
- Carpal tunnel syndrome – Due to entrapped median nerve by the increased mass of subcutaneous tissue in myxedema and acromegaly
- Peripheral neuropathy in DM, trophic ulcers in severe cases and high stepping gait

Breasts, testicles and secondary sexual characters

- Gynecomastia – Sparse facial, axillary and pubic hair in a male due to excess of estrogens and lack of androgens is seen in primary hypogonadism or liver cirrhosis.
- Testicular atrophy in males indicates either primary hypogonadism or hypothalamic pituitary dysfunction or liver cirrhosis.
- Failure/delay in appearance of secondary sex characters (absent or low estrogen levels).
- Delay in puberty or precocious puberty.
- Clitoral hypertrophy (exposure to androgens during 1st-3rd months of fetal development, congenital adrenal virilism).
- Galactorrhea (Galacto-hyperprolactinemia).

A case of acromegaly

Acromegaly is the result of excess GH secretion after epiphyseal closure. Excess GH secretion before epiphyseal closure leads to gigantism (Fig. 7.4). Pituitary adenoma is invariably the cause.

1. **Clinical features** – In addition to features of excess GH, pituitary adenoma may cause headache, visual field defects due to pressure over optic chiasma or there may be cranial nerve involvement (Fig. 7.5). Apart from increase in GH, there may be elevated PRL levels (50% cases) that result in decreased libido, galactorrhea, oligomenorrhea and infertility.
   - **a.** Coarse facial features, prominent supraorbital ridges and malar bones, prognathism of lower jaw with separation of teeth, frontal bossing with large frontal sinuses, thick lips, stubby nose (Fig. 7.6) and enlarged tongue are classical features.
   - **b.** Hands and feet are large and spade like (Fig. 7.7). The skin is thick with excessive sweating and increased heel pad thickness.
   - **c.** Bony overgrowth around weight-bearing joints (knees and ankles), kyphosis.
   - **d.** Carpal tunnel syndrome.
   - **e.** Organomegaly (cardiomegaly, hepatomegaly).

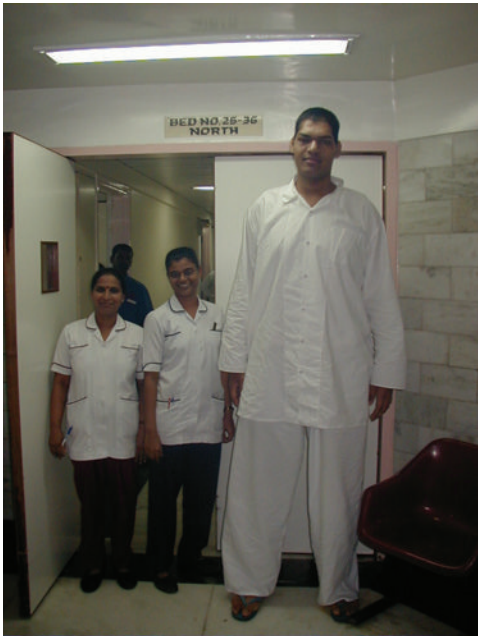

Figure 7.4 A case of gigantism.

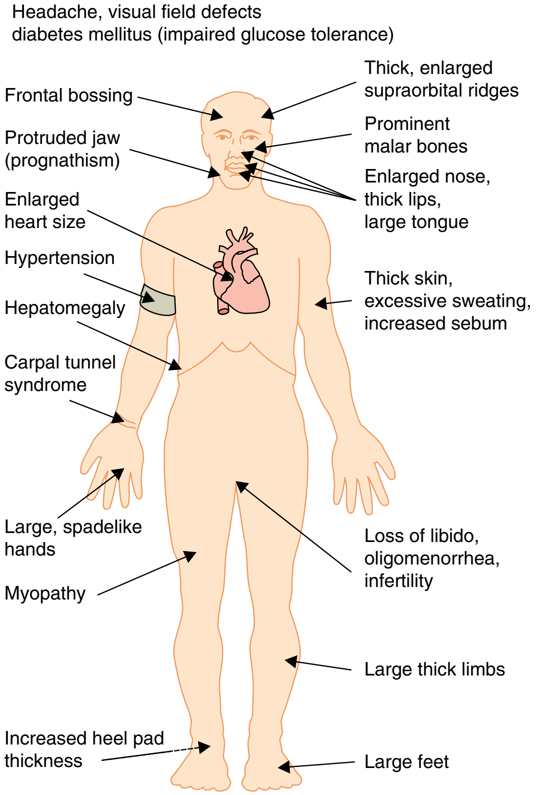
Headache, visual field defects
diabetes mellitus (impaired glucose tolerance)
Frontal bossing
Thick, enlarged supraorbital ridges
Protruded jaw (prognathism)
Prominent malar bones
Enlarged nose, thick lips, large tongue
Enlarged heart size
Hypertension
Hepatomegaly
Thick skin, excessive sweating, increased sebum
Carpal tunnel syndrome
Large, spadelike hands
Loss of libido, oligomenorrhea, infertility
Myopathy
Large thick limbs
Increased heel pad thickness
Large feet

Figure 7.5 Salient clinical features of acromegaly.

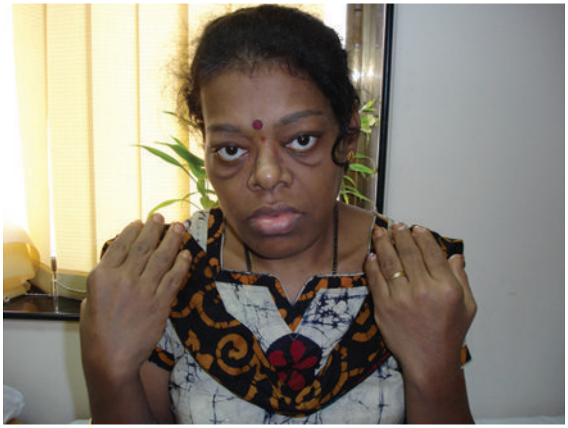

Figure 7.6 A case of acromegaly showing facial features.

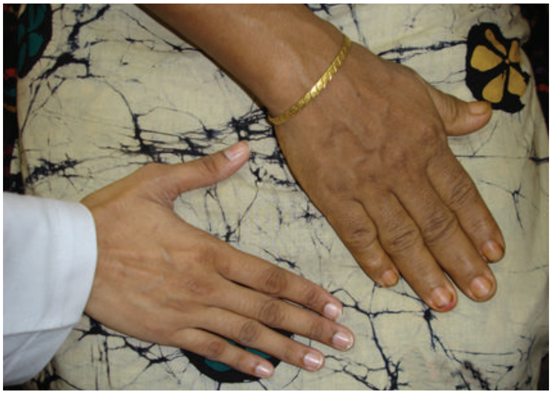

Figure 7.7 Large and spade-like hand in acromegaly compared to normal hand.

- **f.** Obstructive sleep apnea syndrome, hoarse voice (due to hypertrophy of vocal cords).
- **g.** Hypertension, DM may be associated.

Colonic polyps or cancer are more common in these patients. Mortality is high in acromegalics due to malignancies, hypertension, cardiovascular, cerebrovascular, chest complications and associated DM (15–20%).

2. **Investigations**
   - **a.** Measure GH levels during an oral glucose tolerance test. In normal persons, GH is suppressed to less than 2 ng/l, whereas in acromegalics, glucose does not suppress GH; on the contrary, in approximately half of patients, there is paradoxical rise; serum insulin growth factor-1 (IGF-I) levels are elevated.
   - **b.** Administration of TRH to acromegalics causes elevation of GH in two-thirds of patients; normally, there is no rise.
   - **c.** Glucose intolerance/frank DM may be present.
   - **d.** Skull X-ray shows enlarged sella turcica (Fig. 7.8).
   - **e.** Computed tomography/magnetic resonance imaging (CT/MRI) of pituitary fossa to assess enlargement of sella and confirmation of pituitary adenoma (Figs. 7.9 and 7.10).
   - **f.** Examination of visual fields to evaluate pressure on optic chiasma, optic nerve and optic tract.
3. **Management** – The aim of the treatment is to bring down levels of GH and IGF-1 to normal levels and to decrease the size of the tumor

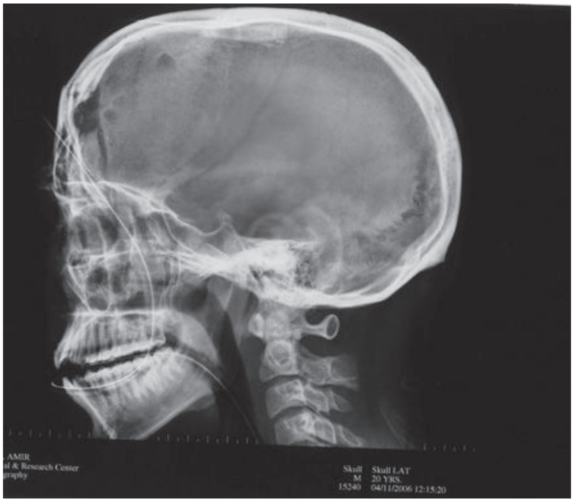
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Figure 7.8 Skull X-ray showing enlarged sella turcica.

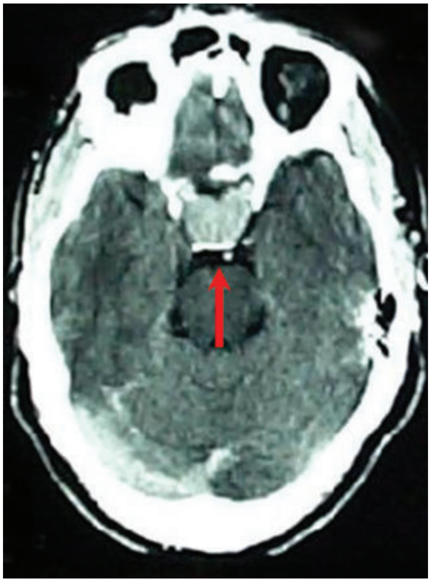

Figure 7.9 Computed tomography – Pituitary adenoma.

with restoration of normal pituitary function. But, unfortunately, in clinical practice it is not feasible to achieve these goals with the available methods of treatment (surgery, medical and radiotherapy).

a. **Surgical treatment** – Transphenoidal surgery (the most accepted method) achieves a cure rate of 20–40%. The GH levels return to less than 2 ng/l with normal levels of IGF-1.

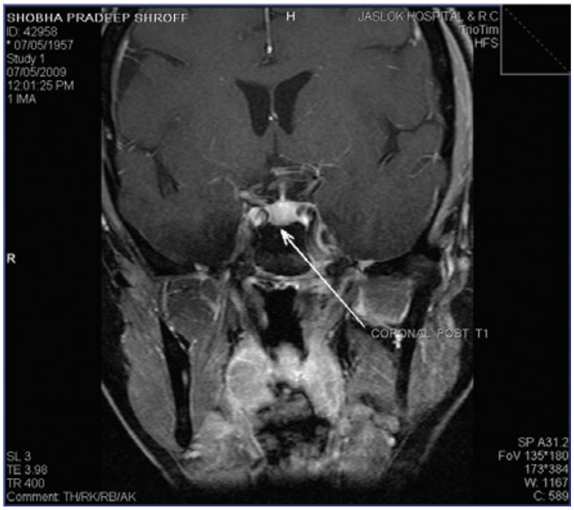
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Figure 7.10 Magnetic resonance imaging – Pituitary adenoma.

b. **Medical treatment**
   i. Octreotide (synthetic analog of somatostatin) (50–200 μg) given subcutaneously every 8 hours lowers GH and IGF-1 levels and causes shrinkage of adenoma.
   ii. Lanreotide (slow release depot somatostatin) (30 mg) given intramuscularly results in suppression of GH and insulin-like growth factor-1 hypersecretion for 10–14 days. All symptoms improve except bone and joint changes, which do not increase but can be stabilized. It also causes shrinkage of GH-producing adenoma.
   iii. Bromocriptine (20–60 mg/day) improves clinical symptoms but does not cause change in tumor size or levels of GH and IGF-1.

c. **Radiotherapy** – It is targeted at pituitary tumor.

Viva voce

Q1. What are the causes of enlarged sella turcica?

- Pituitary tumor
- Pregnancy
- Primary hypothyroidism
- Empty sella syndrome

A case of hyperthyroidism (thyrotoxicosis)

1. **Etiopathology**
   a. There is over synthesis and secretion of thyroid hormones (T3 or T4) due to either thyroid stimulation or autonomous thyroid function.
   b. There is an increased release of thyroid hormones due to thyroiditis.

For causes of hyperthyroidism, see Table 7.1.

Table 7.1 **Causes of hyperthyroidism**

Thyroid disorders

- Toxic diffuse goiter (Grave's disease)
- Toxic solitary or multinodular goiter (Plummer's disease)
- Acute thyroiditis (viral and autoimmune)

Extrathyroidal disorders

- Exogenous iodine ingestion
- Drug induced (amiodarone)
- Factitious thyrotoxicosis
- Struma ovarii (hyperfunctioning ovarian teratoma)
- Molar pregnancy, choriocarcinoma, hyperemesis gravidarum

Increase in TSH

- Inappropriate TSH secretion (TSH secreting tumors, e.g. pituitary)
- HCG-producing tumors

Primary hyperthyroidism (Grave's disease) – clinical features (Fig. 7.11)

- It is the most common cause of hyperthyroidism.
- It is due to stimulatory antibody against thyroid-stimulating hormone receptor.
- Gland is diffusely enlarged (Fig. 7.12) with features of thyrotoxicosis (Table 7.2)
- Often associated with other autoimmune diseases (IDDM, vitiligo, pernicious anemia, connective tissue diseases).
- Eye signs may or may not be present. Mechanism of eye signs (ophthalmopathy; Box 7.2), dermopathy and pretibial edema (which are seen in some cases) are not well understood.

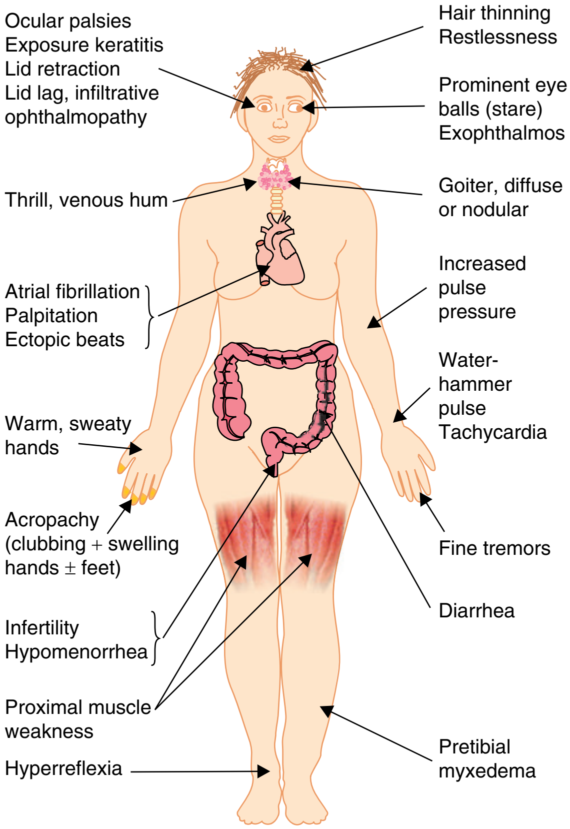
Ocular palsies
Exposure keratitis
Lid retraction
Lid lag, infiltrative ophthalmopathy
Hair thinning
Restlessness
Prominent eye balls (stare)
Exophthalmos
Thrill, venous hum
Goiter, diffuse or nodular
Atrial fibrillation
Palpitation
Ectopic beats
Increased pulse pressure
Warm, sweaty hands
Water-hammer pulse
Tachycardia
Acropachy (clubbing + swelling hands ± feet)
Fine tremors
Diarrhea
Infertility
Hypomenorrhea
Proximal muscle weakness
Pretibial myxedema
Hyperreflexia

Figure 7.11 Clinical features of thyrotoxicosis.

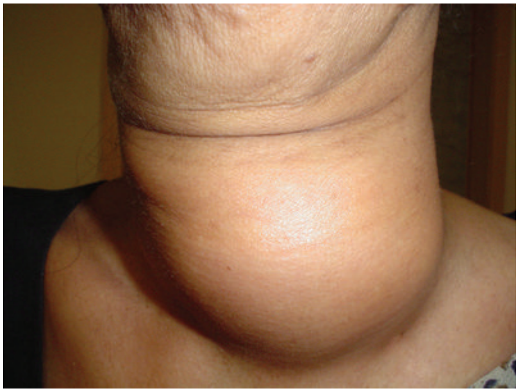

Figure 7.12 Diffuse goiter with hyperthyroidism.

Secondary hyperthyroidism (Plummer's disease)

- Nodular goiter which (at a later stage) becomes hyperfunctional (Fig. 7.13)
- Not associated with other autoimmune diseases
- Remission not common

Table 7.2 **Signs in a case of thyrotoxicosis**

General	Warm body, fine tremors, anxious staring look, restless, sweaty warm hands, palmar erythema, lymphadenopathy, gynecomastia, pretibial myxedema, edema Early stage thyrotoxicosis (Fig. 7.14), advanced stage thyrotoxicosis (Fig. 7.15)
Eyes	Exophthalmos, lid lag, lid retraction, chemosis Ophthalmoplegia* Impaired convergence* Diminished acuity of vision* Corneal ulceration*
Thyroid	Goiter (look for retrosternal extension, consistency, tenderness, thrill, bruit) Stridor, hoarseness of voice (pressure symptoms)
Cardiovascular system (CVS)	Tachycardia/atrial fibrillation, high-volume pulse, hypertension (systolic), cardiomegaly, loud S1, S3, hemic/flow murmur
Abdomen	Splenomegaly ±
Central nervous system (CNS)/ muscle	Proximal muscle weakness, brisk deep tendon reflexes, fasciculations

*Not present in all patients.

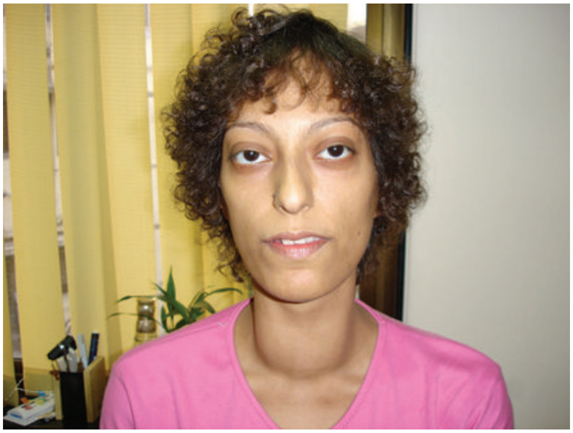

Figure 7.13 Toxic nodular goiter.

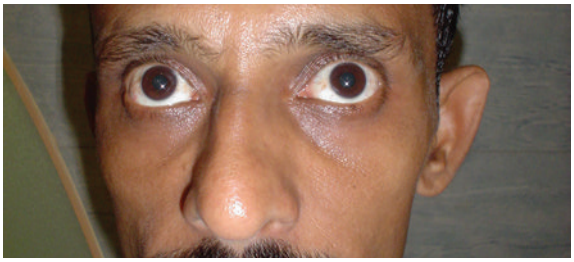

Figure 7.14 Stare – Thyrotoxicosis.

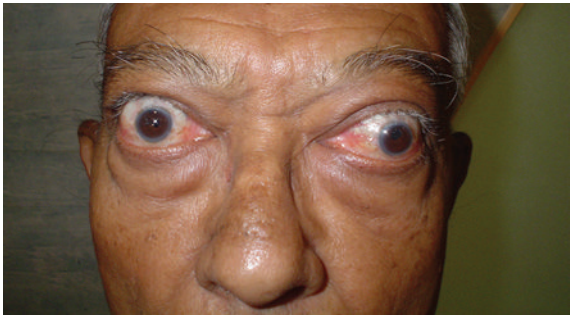

Figure 7.15 Exophthalmos advanced stage.

Ophthalmopathy **Box 7.2**

The American Thyroid Association classification of eye signs of Grave's disease

- No signs or symptoms
- Only signs limited to upper lid retraction (stare, lid lag) – No symptoms
- Soft tissue involvement (symptoms and signs) present
- Proptosis greater than 20 mm
- Extraocular muscle involvement
- Corneal involvement

- May not present with typical features of hyperthyroidism; often presents with symptoms such as apathy, cardiac symptoms such as atrial fibrillation and congestive cardiac failure and neurologic features such as syncope and weakness

1. **Investigations**
   a. Increased levels of T3, T4 and free thyroxine; decreased level of TSH
   b. Thyrotrophic-stimulating hormone levels are high when thyrotoxicosis is secondary to TSH-secreting pituitary adenoma. T4 level can be normal with

T3 thyrotoxicosis or in patients who are severely ill.

c. Nuclear scan (technetium scan) to detect autonomous hyperfunctioning nodule/nodules (Fig. 7.16).

d. Assessment of other systems involvement (cardiovascular system [CVS] and central nervous system [CNS]).

e. Tests for the presence of antibodies.
   - Thyrotrophic-stimulating hormone receptor antibody is found in 70% of patients with Grave's disease.
   - Thyroid-stimulating immunoglobulin is an important marker for the diagnosis of Grave's disease.
   - Antimicrosomal antibodies are seen in Grave's disease and Hashimoto's thyroiditis.
   - Antithyroid peroxidase antibodies are present in most patients with Grave's disease. Antibodies to thyroglobulin are less frequently present. In thyrotoxicosis factitia, serum thyroglobulin levels are low and radioiodine uptake by thyroid gland is low. Low uptake is also seen in hyperthyroidism, secondary to excess iodine ingestion.

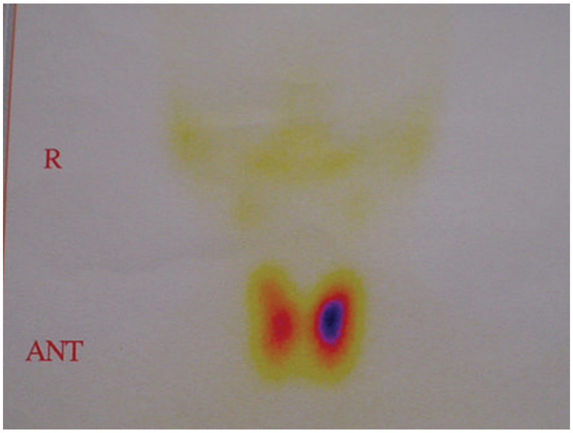

Figure 7.16 Technetium scan showing toxic nodule.

2. **Management** – Treatment of thyrotoxicosis can be medical, radioactive iodine or surgery.

a. **Medical**

i. Neomercazole (5-mg tablet)
   - Treatment is initiated with 30 mg daily (two tablets tds) and tapered slowly. Maintenance dose is 10–15 mg/day. Treatment is continued up to 1 year
   - It is preferred in children and young adults with small diffuse thyromegaly
   - Serious side effects – Skin rash and granulocytopenia (agranulocytosis); regular monitoring of white blood cells necessary
   - Produces remission in 50% of cases. On withdrawal, thyroid gland function restores to normal

ii. Propylthiouracil (100-mg tablet)
   - Not the first drug of choice
   - A dose of 100–150 mg, every 8 hours, is administered to patients allergic to neomercazole (but not with agranulocytosis, when both cannot be used)
   - Other indications – Pregnancy, breastfeeding and treatment of thyroid storm (dose of 800–1200 mg/day is used) as it additionally blocks peripheral conversion of T4 to T3

iii. Symptomatic treatment
   - Beta-blockers. Propranolol is most commonly used. It is also used to treat thyroid storm, when it is administered intravenously. It is also useful in the elderly patients.
   - Calcium channel blockers can be used as an alternative to β-blockers.

b. **Radioiodine therapy** – The most commonly used treatment for thyrotoxicosis.

Dose – Single dose, 5–7 mCu iodine-131 (131 I); 30% of patients may require second dose

Age group – More than 5 years of age

Indication – Indicated in severe thyrotoxicosis and in patients with systemic involvement

Response – Obtained after few weeks to few months

Adverse effects – Radiation thyroiditis (immediate side effect). Hypothyroidism develops over years in almost all patients

Contraindication – Pregnancy

c. **Surgery**

Procedure – Subtotal thyroidectomy

Advantage – Gives immediate symptomatic relief

Age group – All age groups

- **i.** Indications for surgery
  - Recurrence following antithyroid drug or radioiodine therapy
  - Intolerance to drugs
  - Very large goiter
  - Goiter with pressure symptoms
  - Goiter with retrosternal extension
  - Toxic, multinodular goiter in young patients
- **ii.** Complications
  - Thyroid crisis (immediate risk), recurrent laryngeal nerve injury and hypothyroidism (10%) and hypoparathyroidism (10%) are usually late complications.
  - Preoperative control of hyperthyroidism with oral iodine (for 10 presurgery days) is necessary for elective surgery to prevent postoperative thyroid storm.

Special problems

Thyroid crisis (thyroid storm)

It is a life-threatening emergency, it is triggered by

- Thyroid surgery, if preoperative preparation with iodine is not adequate
- Severe stress (emotional, infection)
- Sudden stoppage of antithyroid drugs
- Electrolyte disturbance, uncontrolled DM

Thyroid crisis is usually abrupt in onset, in which all features of hyperthyroidism are enhanced with extreme tachycardia, hyperpyrexia, delirious state, agitation, severe diarrhea, coma and cardiovascular collapse. It is managed in intensive care unit (ICU) as follows:

- Intravenous (IV) sodium iodide 1 g in 24 hours or oral Lugol's iodine (five drops QDS) followed by
- Thionamide or propylthiouracil (800–1200 mg/daily)
- Corticosteroids (dexamethasone)
- Correction of water and electrolyte imbalance

A case of myxedema (hypothyroidism)

1. **Introduction**
   - **a.** Hypothyroidism can present at all ages. Manifestations vary according to the age.
   - **b.** Lack of thyroid hormone in utero leads to irreversible brain damage in the fetus.
   - **c.** In children, it presents as cretinism.
   - **d.** In adults, it presents as myxedema.
2. **Etiology**
   - **a.** Commonest cause of primary hypothyroidism is idiopathic. It is usually seen in middle-aged women
   - **b.** Hashimoto's thyroiditis (autoimmune) is the commonest cause of hypothyroidism associated with goiter in 30–50 years age group
   - **c.** Postsurgery or postradioactive 131 I therapy
   - **d.** Drug toxicity (e.g. iodide, amiodarone, lithium carbonate)
   - **e.** Secondary myxedema due to hypopituitarism (because of TSH deficiency)
   - **f.** Severe iodine deficiency
3. **Prevalence**
   - **a.** **Endemic** – Seen in sub-Himalayan areas due to iodine deficiency. Children present mainly with mental retardation. They have more of neurological manifestations than myxedematous features. Hearing defect worsens intellectual deficiency. Posture and gait are affected (shuffling gait).
   - **b.** **Sporadic** – Either due to dysgenesis of thyroid gland or due to enzyme defect, results in low hormone synthesis. Thyroid gland may be damaged by viral infection or irradiation.
4. **Clinical features (Fig. 7.17 and Table 7.3)**
5. **Investigations**
   - **a.** Low T3 and T4 levels with raised TSH in primary hypothyroidism; low level of T4 is more reliable than T3 level (Box 7.3). High TSH level is diagnostic.
   - **b.** In secondary hypothyroidism, both TSH and T4 levels are low.
   - **c.** Electrocardiogram (ECG) shows bradycardia with low voltage. T waves are flat or inverted.
   - **d.** Serum enzymes LDH and CPK levels are high.
   - **e.** Thyroglobulin or microsomal antibodies in high titer indicate chronic autoimmune (Hashimoto's) thyroiditis.
   - **f.** Photomotograph – Delay in muscle relaxation can be recorded by the recording

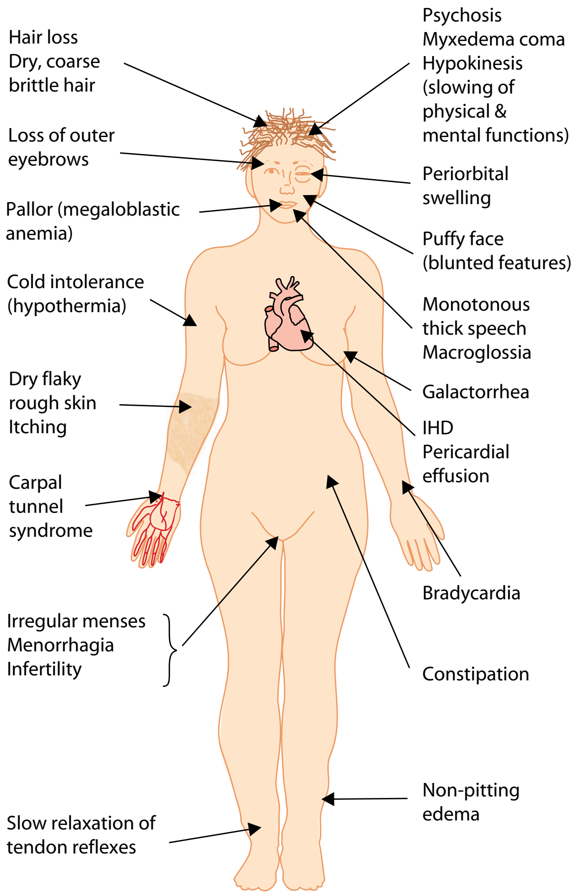
Hair loss
Dry, coarse brittle hair
Loss of outer eyebrows
Pallor (megaloblastic anemia)
Cold intolerance (hypothermia)
Dry flaky rough skin Itching
Carpal tunnel syndrome
Irregular menses
Menorrhagia
Infertility
Slow relaxation of tendon reflexes
Psychosis
Myxedema coma
Hypokinesis (slowing of physical & mental functions)
Periorbital swelling
Puffy face (blunted features)
Monotonous thick speech
Macroglossia
Galactorrhea
IHD
Pericardial effusion
Bradycardia
Constipation
Non-pitting edema

Figure 7.17 Clinical features of myxedema.

Table 7.3 Signs of myxedema

General examination	Puffy face, baggy lower eyelids, periorbital edema, pallor, coarse features, coarse dry hair, loss of outer eyebrows (Fig. 7.18)
Thyroid	Thyromegaly (exclude retrosternal extension)
	Thyroidectomy scar
Cardiovascular system	Cardiomegaly, pericardial effusion
	Bradycardia
	Hypertension
Nervous system	Slowness of cerebration, confused
	Diminished hearing
	Slow relaxation of deep tendon reflexes (especially ankle), half relaxation time is prolonged
	Chvostek's sign positive (if hypoparathyroidism is associated)
Musculoskeletal	Proximal muscle weakness
	Percussion myokymia
	Carpal tunnel syndrome
	Puffy/swollen hands
Abdomen	Ascites if present – Look for CCF
Others	Cold intolerance, low body temperature
	Dry and pale skin, vitiligo
	Xanthelasma, xanthomas
	Peripheral edema (nonpitting)
	Gynecomastia
	Galactorrhea
	Alopecia

Causes of low free T4 **Box 7.3**

- Hypothyroidism
- Thyroxine-binding globulin deficiency
- Drugs (e.g. lithium, amiodarone)

of ankle jerk (Fig. 7.19 showing slow relaxation).

6. **Complications**

   Myxedema coma

   a. Not all experts agree that hypothyroidism alone can be the cause of coma. Often an associated critical illness is present.
   b. It is a life-threatening complication.
   c. It usually occurs in long-standing hypothyroidism.
   d. Precipitating factors of coma are exposure to severe cold, infection, hypnotics, anesthetic agents and trauma.

Cardinal features of myxedema coma

- Coma
- Extreme hypothermia (temperature 24–32 °C)
- Bradycardia
- Hypoventilation with CO_2 retention (respiratory depression)
- Hypotension
- Convulsions, areflexia
- Hyponatremia

Investigations of myxedema coma

Low T4 and very high TSH.

6. **Management of myxedema**

   a. Replacement therapy – l-thyroxine is preferred (usual maintenance dose is 75–125 µg OD; to be taken on empty

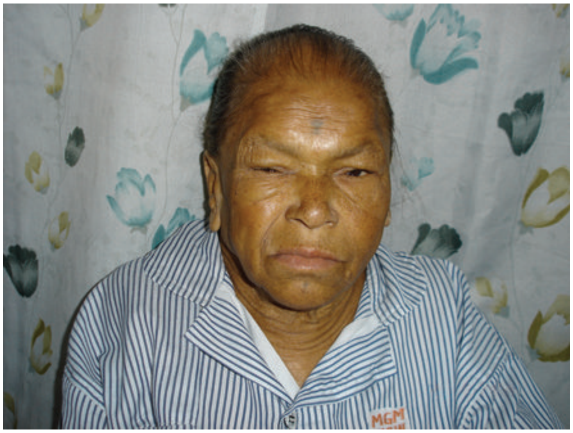

Figure 7.18 A case of myxedema.

stomach). Dose is adjusted to achieve serum. TSH, T3 and T4 levels in the normal range.

b. While on l-thyroxine, monitor pulse rate, weight, ankle reflexes, T3, T4 and TSH levels periodically.

c. In the presence of ischemic heart disease (IHD), thyroxine is started with a smaller dose (25 µg OD) and is increased gradually (every 4–6 weeks to avoid precipitating ischemic episodes). Elderly patients may require a lesser maintenance dose. During pregnancy, the requirement of thyroxine is higher. The maintenance dose should achieve TSH level in the mid-normal range.

Treatment of myxedema coma

- Gradually warm the patient; correct hypoventilation, hypotension and hyponatremia.
- Start with IV T4 (50 µg), given slowly. Repeat IV T4 (50 µg) daily till patient is conscious. Then, l-thyroxine can be given orally.
- Intravenous hydrocortisone (50–100 mg) must be administered every 8 hours to avoid precipitation of adrenal crisis.
- Intravenous fluids must be administered slowly with caution as these patients do not excrete water appropriately. Patient may need mechanical ventilation.
- Any other medications should be given in lower dosage as they are metabolized slowly.
- Cardiac status (for failure) should be monitored carefully.
- Associated illnesses must be treated.

Viva voce

Q1. What are the causes of unilateral exophthalmos?
- Grave's disease
- Cavernous sinus thrombosis
- Caroticocavernous fistula (pulsatile exophthalmos)
- Rhinocerebral mucormycosis
- Wegner's granulomatosis
- Pseudotumor oculi
- Retro-orbital tumor

Q2. Which muscle disorders are associated with thyroid diseases?
- Proximal myopathy
- Ophthalmoplegia
- Myasthenia gravis
- Hypokalemic periodic paralysis
- Pseudomyotonia

Q3. Enumerate causes of thyrotoxicosis with low/poor radioiodine uptake.
- Acute thyroiditis
- Subacute thyroiditis
- Hashimoto's thyrotoxicosis
- Postpartum thyroiditis
- Iodine treatment (Jode-Basedow phenomenon) of goiter

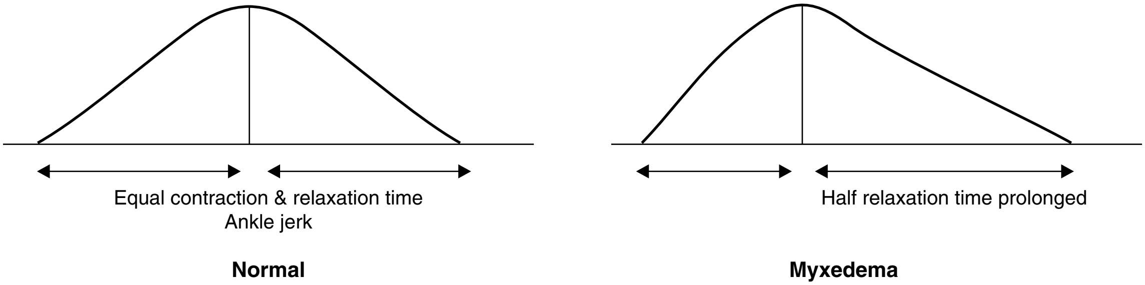
Equal contraction & relaxation time
Ankle jerk
Normal
Half relaxation time prolonged
Myxedema

Figure 7.19 Graph showing prolonged relaxation time.

- Factitious thyrotoxicosis
- Functioning thyroid carcinoma metastasis
- Struma ovarii

Parathyroid

1. **Introduction** – There are four parathyroid glands, which are situated posteromedial to thyroid gland. The main constituents of parathyroid glands are chief cells that secrete parathormone (PTH). The main actions of PTH are on vitamin D metabolism, bone and kidneys.
    a. Vitamin D3 (cholecalciferol) is the main form of vitamin D derived from food and is also synthesized in skin on exposure to sunlight. Cholecalciferol is hydroxylated to 25 hydroxyl cholecalciferol in the liver and is the main circulating form of vitamin D. It is further hydroxylated in the kidney to give 1α,25 dihydroxycholecalciferol (1,25-DHCC) and is the most potent form of vitamin D3. (It reflects storage.) Parathormone stimulates this second hydroxylation in the kidney. The main actions of 1,25-DHCC are to enhance intestinal absorption of calcium and phosphate and along with PTH to mobilize calcium from bone.
    b. Bone contains 99% of total body calcium. Parathormone stimulates bone resorption and mobilizes calcium from bone to the extracellular fluid.
    c. Renal action – PTH stimulates tubular reabsorption of calcium and increases excretion of phosphate and bicarbonate.

A case of hyperparathyroidism

There are three types of hyperparathyroidism

- Primary – It is due to parathyroid adenoma (commonest cause), or hyperplasia or carcinoma (rare).
- Secondary – It is due to compensatory hyperplasia of parathyroid secondary to low serum calcium. This restores calcium levels at the expense of osteolysis of bones.
- Tertiary – In a small proportion of cases with secondary hyperparathyroidism, hypersecretion of PTH may continue even though calcium levels get normalized, and it is due to adenoma formation with autonomous PTH secretion.

1. **Clinical features (Fig. 7.20)**
2. **Investigations**
    a. Elevated serum calcium
    b. Elevated PTH
    c. Low serum phosphate
    d. Serum alkaline phosphatase may be elevated
    e. X-ray hands – subperiosteal resorption of the phalanges on radial aspect (Fig. 7.21)
    f. Resorption of terminal phalanges
    h. Lateral view skull X-ray shows osteolytic lesions resembling 'pepper-pot' appearance
    i. Nephrocalcinosis
    j. Localization of parathyroid tumor – High-resolution ultrasonography or high-resolution CT scan, MRI and Technetium-99 Sestamibi scan are helpful.

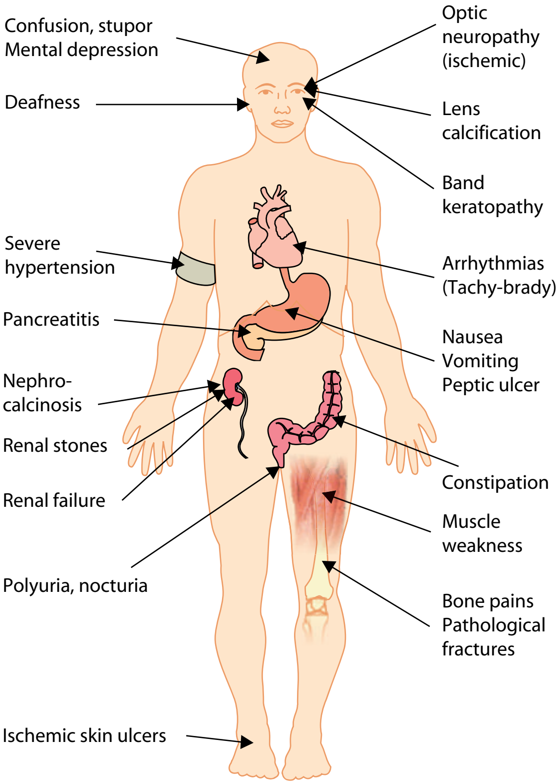
Confusion, stupor
Mental depression
Deafness
Severe hypertension
Pancreatitis
Nephro-calcinosis
Renal stones
Renal failure
Polyuria, nocturia
Ischemic skin ulcers
Optic neuropathy (ischemic)
Lens calcification
Band keratopathy
Arrhythmias (Tachy-brady)
Nausea
Vomiting
Peptic ulcer
Constipation
Muscle weakness
Bone pains
Pathological fractures

Figure 7.20 Salient clinical features of hyperparathyroidism.

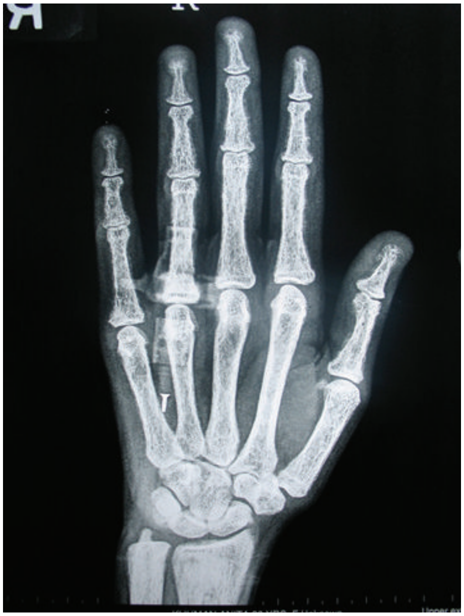

Figure 7.21 Subperiosteal erosions in the phalanges.

3. **Management** – The main and curative therapy is surgical removal of the adenoma. In case of hyperplasia, all four glands are removal and a portion of the excised tissue is transplanted subcutaneously usually the forearm or in the belly of sternomastoid muscle or in any part of the body. Following surgery, the resulting hypocalcemia is managed by oral calcium supplements.

A case of hypoparathyroidism

Clinical features (Fig. 7.22)

In hypoparathyroidism, serum calcium is low and serum phosphate is elevated. Patient may present with tetany. The commonest cause of hypoparathyroidism is total thyroidectomy. Idiopathic hypoparathyroidism may present at any age and is sometimes accompanied with autoimmune disorders of adrenal, thyroid or ovary. Due to prolonged hypocalcemia, in addition to tetany, psychosis, grand mal epilepsy, cataracts, basal ganglia calcification and papilledema may be present.

Pseudohypoparathyroidism

It is an autosomally inherited disorder. Parathormone though present is ineffective, as there is tissue resistance. Patients have clinical and biochemical features of hypoparathyroidism. They have typical skeletal abnormalities such as short stature and short 4th and 5th metacarpals and metatarsals. Levels of serum PTH are high, but the serum calcium levels are normal.

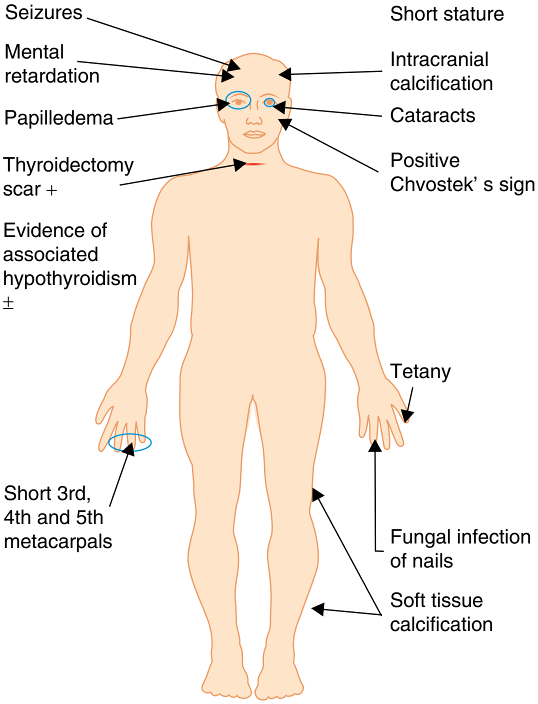
Seizures
Mental retardation
Papilledema
Thyroidectomy scar +
Evidence of associated hypothyroidism ±
Short 3rd, 4th and 5th metacarpals
Short stature
Intracranial calcification
Cataracts
Positive Chvostek' s sign
Tetany
Fungal infection of nails
Soft tissue calcification

Figure 7.22 Clinical features of hypoparathyroidism.

1. **Management**
   - a. Parathyroid hormone preparations are unsatisfactory as they soon become ineffective. Patients presenting in acute phase (postoperative) with tetany are treated with IV calcium.
   - b. Patients of chronic hypoparathyroidism and pseudohypoparathyroidism are treated either with α-calcidol (1α--hydroxycholecalciferol) or calcitriol (1,25-DHCC; 1–3 µg daily). Serum calcium should be monitored periodically.

A case of Cushing's syndrome

Cushing's syndrome is due to excess glucocorticoid production.

1. **Endogenous type**
   - a. **Causes**
     - i. Primary adrenal hyperplasia or tumor (Cushing's syndrome)

ii. Secondary to excess ACTH secretion
  - Pituitary tumor (Cushing's disease)
  - Excessive corticotrophin-regulating hormone (CRH)
  - Ectopic ACTH-secreting tumor (Paraneoplastic tumor in bronchogenic carcinoma)

b. Clinical presentation (Fig. 7.23)

i. Usually affects middle-aged women

ii. Moon facies, plethoric appearance (Fig. 7.24)

iii. Truncal obesity, buffalo hump and prominent supraclavicular fat pads with thin extremities. Truncal obesity with violet-colored abdominal striae is common (Fig. 7.25)

iv. Thin and atrophic skin, easy bruising, poor wound healing, and acne

v. Muscle wasting and weakness

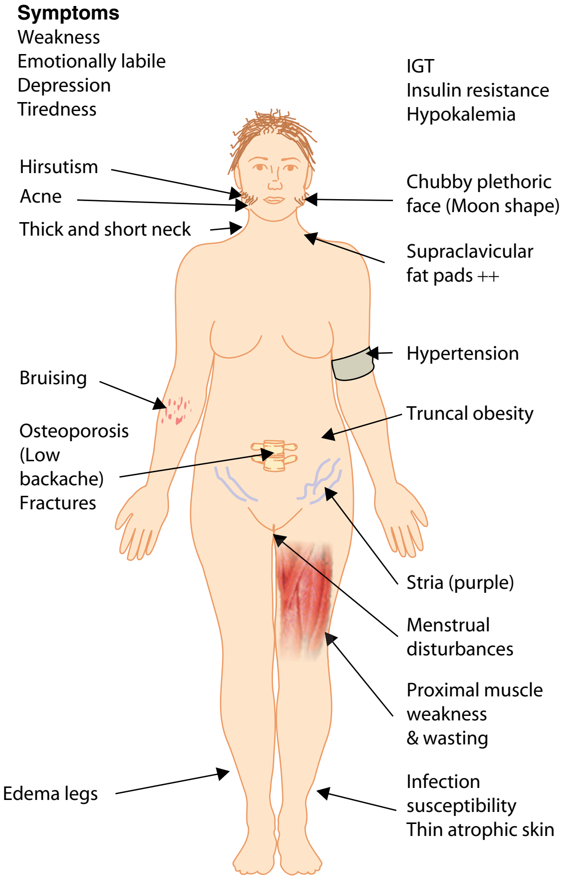
Symptoms
Weakness
Emotionally labile
Depression
Tiredness
IGT
Insulin resistance
Hypokalemia
Hirsutism
Acne
Thick and short neck
Chubby plethoric face (Moon shape)
Supraclavicular fat pads ++
Hypertension
Bruising
Truncal obesity
Osteoporosis (Low backache) Fractures
Stria (purple)
Menstrual disturbances
Proximal muscle weakness & wasting
Edema legs
Infection susceptibility
Thin atrophic skin

Figure 7.23 Clinical features of Cushing's syndrome.

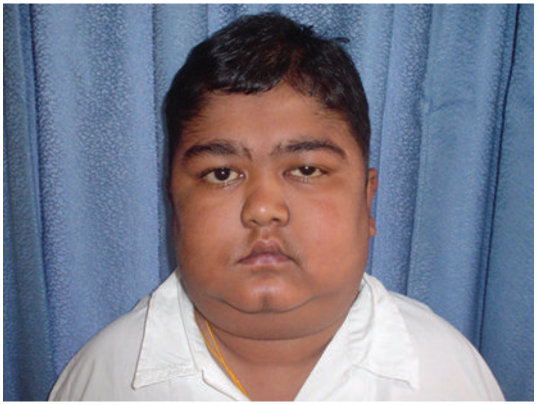

Figure 7.24 Cushing's syndrome showing moon facies.

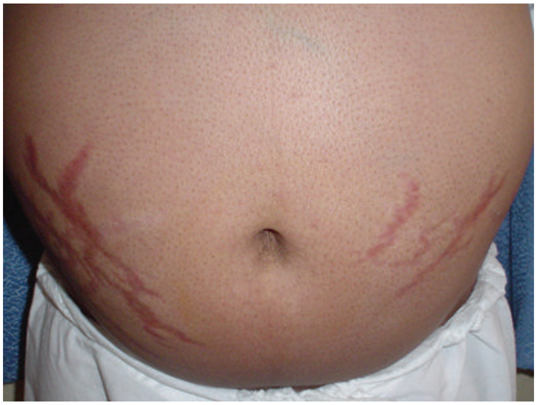

Figure 7.25 Truncal obesity with violet-colored striae.

vi. Systemic manifestations – Hypertension, glucose intolerance, osteoporosis, renal calculi, increased susceptibility to infections including tuberculosis, fungal infections and mental disturbances

vii. In children – Cessation of linear growth

viii. In females – Menstrual irregularities

ix. In adrenal tumors – Features of androgen excess such as hypertrichosis, temporal balding and signs of virilism in females may be present

2. **Exogenous type** – One month of treatment with glucocorticoid can result in Cushing's syndrome. These patients are more likely to suffer from glaucoma, cataract, avascular necrosis of femur and panniculitis. Features of mineralocorticoid and androgen hormone excess are rare in this group.

- **c. Diagnosis** – It is based on following investigations
  - **i.** Elevated serum cortisol levels.
  - **ii.** Increased 24 hours urinary free cortisol (UFC) (more than 120 μg/24 hours) and UFC greater than four times the upper limit of normal is almost diagnostic of Cushing's syndrome.
  - **iii.** Circadian rhythm of plasma cortisol (8 a.m. and midnight) is lost. Normally, cortisol levels are lowest at midnight, but they remain same throughout in Cushing's syndrome.
  - **iv.** Dexamethasone suppression test – 1, 1.5 or 2.0 mg of dexamethasone is administered at midnight and plasma cortisol level is measured the next day morning (8–9 a.m.). Plasma cortisol level greater than 180 mmol/l is abnormal.
  - **v.** Alternatively, patient is given dexamethasone 0.5 mg orally, every 6 hours for 2 days. Failure to suppress UFC establishes the diagnosis.
  - **vi.** In patients with pituitary tumor, plasma ACTH level is raised, whereas in Cushing's syndrome secondary to adrenal pathology, it is almost undetectable without and even with corticotrophic regulating hormone (CRH) stimulation.
  - **vii.** On metyrapone testing, patient with pituitary tumor shows increase in steroid levels.
  - **viii.** Computed tomography, magnetic resonance imaging, positron emission tomography scans and radiolabeled octreotide scan are useful to locate the site of tumor.
- **d. Management**
  - **i. Surgical**
    - Removal of adrenal tumor. Perioperatively, steroids must be given.
    - For Cushing's disease (due to pituitary tumor), pituitary microsurgery is the treatment of choice.
    - Younger patients are treated with pituitary gland irradiation.
    - Ectopic ACTH-producing tumor is treated by removal.
    - Bilateral adrenalectomy may be considered in a few cases of pituitary hyperadrenocorticism who do not respond to other treatment. Lifelong replacement therapy with glucocorticoid and mineralocorticoid is required.
  - **ii. Medical**
    - Metyrapone (11-hydroxylase inhibitor) 1–2 g in divided doses per day, combined with aminoglutethimide 1 g/day to inhibit cortisol secretion
    - Ketoconazole (200–400 mg BD or TDS) – most frequently used but has many side effects, especially hepatotoxicity

Nelson's syndrome

Nelson's syndrome occurs in patients who have undergone bilateral adrenalectomy in Cushing's disease due to ACTH-secreting pituitary adenomas. The pituitary continues to enlarge, and patients get headache and visual disturbances. Plasma ACTH levels are very high. Treatment is removal of pituitary adenoma followed by irradiation. Alternatively to reduce the levels of ACTH, bromocriptine, cyproheptadine or valproic acid may be used.

A case of Addison's disease (primary adrenocortical deficiency)

1. **Introduction**
   - **a.** Addison's disease is due to insidious, slowly progressive destruction of the adrenal glands.
   - **b.** Tuberculosis is the commonest cause in India. Autoimmune destruction is another common cause.
   - **c.** Uncommon causes are viral infection (especially HIV), sarcoidosis, histoplasmosis, amyloidosis, metastasis and radiation.
   - **d.** Hypoadrenalism may sometimes be due to drugs that block corticosteroid synthesis e.g. ketoconazole.
2. **Clinical features** (Fig. 7.26) – Clinical features are due to glucocorticoid and mineralocorticoid deficiencies and secondary rise in ACTH.
   - **a.** Glucocorticosteroid deficiency leads to
     - **i.** Increased insulin sensitivity resulting in hypoglycemia
     - **ii.** Disturbance of carbohydrate, fat and protein metabolism
     - **iii.** Hypotension

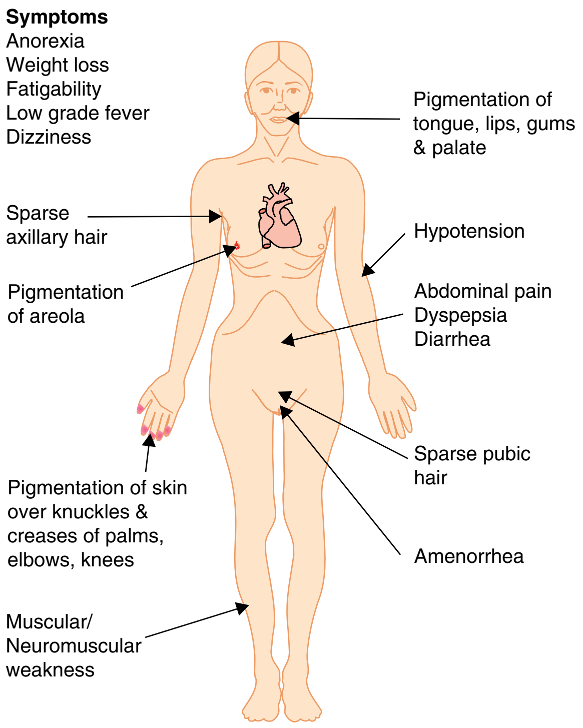
Symptoms
Anorexia
Weight loss
Fatigability
Low grade fever
Dizziness
Pigmentation of tongue, lips, gums & palate
Sparse axillary hair
Hypotension
Pigmentation of areola
Abdominal pain
Dyspepsia
Diarrhea
Sparse pubic hair
Pigmentation of skin over knuckles & creases of palms, elbows, knees
Amenorrhea
Muscular/ Neuromuscular weakness

Figure 7.26 Clinical features of Addison's disease.

   - **iv.** Increased susceptibility to infections and stress
- **b.** Mineralocorticosteroid deficiency leads to
   - **i.** Loss of Na^+ with K^+ retention (hyponatremia with hyperkalemia)
   - **ii.** Inability to concentrate urine (dehydration)
   - **iii.** Hypovolemia (hypotension)
   - **iv.** Acid base disturbances – Acidosis
- **c.** Elevated ACTH production leads to
   - **i.** Hyperpigmentation of skin (not a feature of adrenal insufficiency secondary to pituitary failure)

Note – Addison's disease may be associated with polyglandular autoimmune syndrome.

3. Investigations

- **a.** Blood – Low serum cortisol levels with raised ACTH levels
- **b.** Hyponatremia, hyperkalemia, hypoglycemia (Na less than 130 mEq/l, K greater than 5 mEq/l, blood sugar less than 50 mg/dl)
- **c.** Small heart
- **d.** Neutropenia with relative lymphocytosis and eosinophilia, anemia, elevated hematocrit
- **e.** Low HCO_3 (less than 20 mEq/l) and raised blood urea nitrogen (greater than 20 mg/dl)
- **f.** Calcification of adrenal glands (in some cases with tuberculous etiology)
- **g.** Associated conditions, e.g. pulmonary and renal tuberculosis, other endocrine glandular affection
- **h.** In addition to antiadrenal antibodies, patients may have antibodies against thyroid, gonads, pancreas and parathyroid glands

Secondary adrenocortical insufficiency

It may be due to pituitary or hypothalamic disorders. The main differences in presentation are absence of pigmentation because of low ACTH levels, electrolyte disturbances are absent as aldosterone secretion is preserved and patients may show other features of hypopituitarism.

Note – Prolonged treatment with glucocorticoid steroids is an important cause of secondary adrenal insufficiency.

4. Diagnosis of Addison's disease

- **a.** Low cortisol (less than 5 µg/dl) with high ACTH levels (greater than 50 pcg/ml)
- **b.** Low levels of urinary cortisol, 17-hydroxycorticoids and 17-ketosteroids
- **c.** Adrenocorticotrophic hormone levels help in differentiating primary from secondary adrenal insufficiency. An abnormal response to metyrapone or insulin hypoglycemia establishes the diagnosis of secondary adrenal insufficiency.
- **d.** Adrenocorticotrophic hormone fails to increase cortisol level in ACTH stimulation test.
- **e.** Imaging of adrenals for primary Addison's disease and pituitary and hypothalamus for secondary Addison's disease. There may be hemorrhage, infiltration and calcification of adrenals.
- **f.** Evidence of pulmonary or renal tuberculosis.

5. Management of Addison's disease

Life-long hormone replacement therapy with glucocorticoid and mineralocorticoid is required.

Either hydrocortisone (20 mg at 8 A.M., 15 mg at 5 P.M.) or prednisolone (5 mg at 8 A.M., 2.5 mg at 5 P.M.) is given to mimic normal circadian rhythm.

9α-Fluorocortisol (0.1 mg/day, orally) is given to correct electrolyte abnormalities (dose would vary according to serum electrolyte levels). Cortisone is to be taken with meals or milk. Glucocorticoid dose is adjusted according to weight gain, blood pressure (BP) and blood glucose.

In secondary adrenal insufficiency, only substitution of glucocorticoid is necessary. Mineralocorticoid replacement is not required. Other pituitary hormones need to be replaced when due to pituitary cause.

Additional intake of sodium salt in diet is advised.

Acute adrenal insufficiency (adrenal crisis)

It occurs with severe infection, surgery, trauma, acute gastrointestinal disorders and rapid withdrawal of corticosteroids. In septicemia, particularly meningococcal and pseudomonas, there is acute adrenal destruction due to hemorrhage (Waterhouse–Friderichsen syndrome). Patients develop hypovolumic shock and severe dehydration. There are severe abdominal, back or leg pains, nausea, vomiting, hypotension and renal shutdown. The diagnosis is confirmed by the presence of hyponatremia, hyperkalemia, hypoglycemia, lymphocytosis and eosinophilia. High blood urea and hypercalcemia may be present due to extracellular fluid loss.

Principles of management of acute adrenal crisis

- Intravenous administration of 5% dextrose saline
- Intravenous administration of hydrocortisone hemisuccinate (100–200 mg stat IM and repeated every 6 hours)
- Once crisis is over, replace hydrocortisone with oral prednisolone and IV fluids with oral fluids and extra salt
- Identify and treat the precipitating cause
- Prompt and vigorous treatment of infections to prevent adrenal crisis. Need to double the dose of steroid during stress periods. Patients are advised to wear a bracelet or carry a card giving the diagnosis of Addison's disease and instructions to administer corticosteroid. Fluorocortisone dose needs to be increased during hot weather as salt loss is significant

A case of pheochromocytoma

1. **Introduction** – The tumor arises from chromaffin cells of sympathoadrenal system. It is mostly benign (10% malignant) and presents with hypertension and features of sympathetic overdrive, 10% arise from extra-adrenal sympathetic tissue. Pheochromocytoma affects all age groups but mostly in young adults (20–40 years) and is one of the treatable causes of secondary hypertension.

Majority of the tumors secrete both adrenaline and noradrenaline.

2. **Clinical features** – Patient usually presents with episodic symptoms of headache, palpitation, pallor, sweating, apprehension, fear of death, nervousness and discomfort in chest or abdomen along with fluctuating BP. Hypertension may be paroxysmal or persistent. Patients have associated hyperglycemia or IGT. Some patients may present with stroke, left ventricular failure (LVF) or acute myocardial infarction (AMI) due to sudden rise of BP. Attacks are precipitated by exercise, severe anxiety, micturition, alcohol binge, smoking/tobacco chewing, morphine, atropine and general anesthesia.

Neurofibromatosis may be associated with pheochromocytoma.

3. **Investigations**
    - **a.** 24 hours urinary vanillylmandelic acid (3-methoxy-4-hydroxymandelic acid)
    - **b.** 24 hours urinary catecholamines
    - **c.** 24 hours urinary metanephrines
    - **d.** Plasma catecholamines (adrenaline and noradrenaline) are more reliable
    - **e.** To localize the tumor, CT of abdomen is done (Fig. 7.27)
    - **f.** Scintigraphy using meta-iodophenyl guanidine (MIBG) helps in localizing the tumor as MIBG labeled with radioactive iodine is taken up by pheochromocytoma (Fig. 7.28)
    - **g.** Gallium scanning is even better to localize pheochromocytoma

24 hours urinary catecholamines

Normal values	
Total	<100 μg/24 hours
Adrenaline	<25 μg/24 hours
Noradrenaline	<75 μg/24 hours

Plasma catecholamines

	Normal values	During hypertensive crisis
Adrenaline	<100 pg/ml	>300 pg/ml
Noradrenaline	<500 pg/ml	>1500 pg/ml

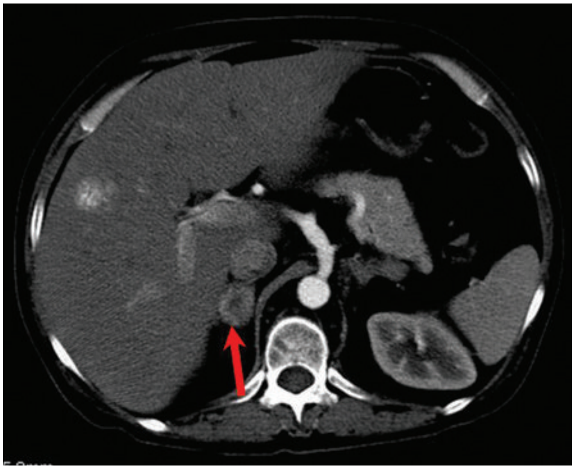

Figure 7.27 Computed tomography abdomen showing pheochromocytoma.

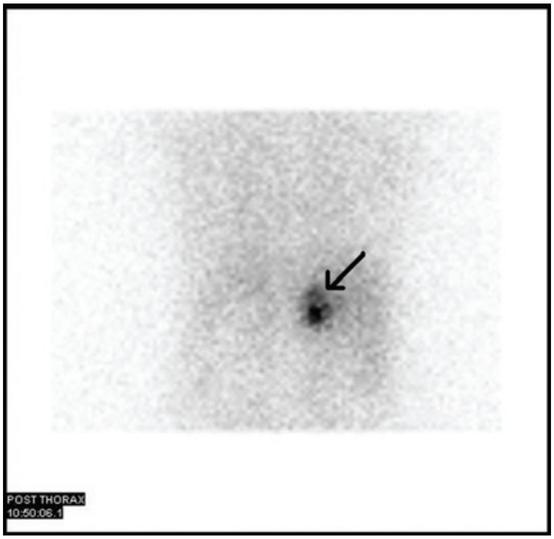

Figure 7.28 Meta-iodophenyl guanidine scintigraphy showing pheochromocytoma.

4. **Management**
    a. **Medical**
        i. **Hypertensive crisis**
            - Hospitalize the patient
            - Bed rest with backrest
            - Phentolamine (α-blocker) 2.5 mg IV, administered every 5 minutes till BP is stabilized
            - Beta-blockers after α-blocker to control arrhythmias (sinus tachycardia)
            - If above measures do not succeed in lowering BP, sodium nitroprusside (100 mg in 500 ml glucose as IV drip)
            - Hydrate the patient with IV fluids
        ii. **For long-term control of hypertension**
            - Long-acting α-blocker (phenoxybenzamine) 10–20 mg BD or
            - Prazocin (1–2 mg TDS)
            - Beta-blocker (propranolol 10–20 mg BD) after giving α-blocker
            - Alternatively, give only labetalol (10 mg BD)
    b. **Surgical** – The ideal treatment is removal of tumor. Prior to surgery, patient has to be prepared by giving α-blocker (phenoxybenzamine) 10–20 mg TDS for 6 weeks. If there is tachycardia with α-blocker, then β–blocker (propranolol 10 mg TDS) is given. Beta-blocker should not be given before α-blocker. For prevention of hypertensive crisis during surgery, sodium nitroprusside and short-acting α-blocker (phentolamine) are used. Postoperative hypotension is prevented by IV fluids and adequate α-blockers before surgery.

Diabetes mellitus

1. **Introduction** – Diabetes mellitus is the most common endocrine disorder. It affects metabolism of carbohydrates, proteins and fats due to defect in insulin secretion, insulin action or both. There are acute complications (infections, coma) and chronic vascular complications such as microangiopathy (retinopathy, nephropathy, neuropathy) and aggravation of macroangiopathy (coronary artery disease, cerebrovascular disease and peripheral vascular disease). It is estimated that India will become the capital of DM by 2020 and 50% of the patients with diabetes in the world will be Indians.

2. **Clinical types**

IDDM	Insulin-dependent DM
NIDDM	Noninsulin-dependent DM
FCPD	Fibrocalculous pancreatic DM
PDDM	Protein-deficient DM

3. **Histopathological changes in pancreas** – In IDDM, there is extensive destruction of β cells. About 90% of patients do not have functioning β cells by the time of presentation.

In NIDDM, there is fibrosis and hyalinization of islets; hyalinization is probably due to deposition of amyloid (special type). The functioning islet cell and β cell number is reduced depending upon the duration of DM.

In PDDM, pancreatic changes are not significant, whereas in FCPD, changes are extensive. Though the size of pancreas is almost normal, there are firm nodules on surface. Pancreatic calculi (calcium carbonate) are present within the pancreatic ducts. Acinar tissue is atrophic, and there is extensive preductal and intra-acinar fibrosis. Islets may show loss, atrophy or hypertrophy.

4. **Clinical features**

   a. **Insulin-dependent diabetes mellitus**
      - Presents at young age (4–30 years), with an equal M:F ratio. It is more prevalent amongst western countries (Caucasians) than in India. Genetic predisposition (heredofamilial) – Heredity plus strong HLA association
      - Onset of disease is rapid; patients present with the classical features of DM, i.e. polyuria, polydipsia and polyphagia. Additional features are tiredness, weakness, weight loss despite good appetite, paresthesias, cramps, pain in lower limbs, giddiness and blurring of vision. Patient is thin built. Some present with ketoacidosis.
      - Build – Thin
      - Lack of insulin – Severe
      - Insulin resistance – Rare
      - Insulin requirement – Low to moderate
      - Islet cell antibodies – Present
      - Ketosis – Prone
      - Sulfonylureas/biguanides – Poor response
      - Common causes of death – Ketoacidosis, hypoglycemia, renal failure, coronary heart disease (CHD).

   b. **Noninsulin-dependent diabetes mellitus**
      - Prevalence – 90–95% of all diabetics (highest in Pima Indians, low in Eskimos)
      - Presents during middle age (35–65 years) with M > F in India, F > M (globally)
      - Genetic – Heredity +++, no HLA association
      - Usual onset – Slow, insidious
      - May remain asymptomatic and detected only during routine check up. Weakness, tiredness, cramps in legs, recurrent boils, delayed healing of wounds, pruritus vulvae and fungus infection often leads to blood glucose estimation. Patients may present with CHD, cardiovascular disease, hypertension or renal failure.
      - Patients tend to be obese, but in Indians leanness is not unusual.
      - Insulin lack – ±
      - Insulin resistance – +++, particularly in obese
      - Insulin requirement – Low, moderate, high
      - Islet cell antibodies – Absent
      - Ketosis – Not prone
      - Sulfonylureas, biguanides, vildagliptin, sitagliptin – Good response
      - Common causes of death – CHD, stroke, renal failure, gangrene

   c. **Fibrocalculous pancreatic diabetes mellitus**
      In certain cassava growing areas, patients present with recurrent attacks of abdominal pain, gaseous distension and large stools. These may precede the development of DM. Patients are emaciated and asthenic. Parotid glands are enlarged. Plain X-ray of abdomen shows pancreatic calculi and calcification.

   d. **Protein-deficient diabetes mellitus**
      Patients come from low socioeconomic group and are thin and emaciated with stunted growth. They present with extreme asthenia, voracious appetite, paresthesia, dermatitis, cramps, amenorrhea and bilateral parotid gland enlargement.

Differential features of FCPD and PDDM:

	FCPD	PDDM
1. Usual age of onset	12–36 years	10–35 years
2. Sex	M > F	F > M
3. Prevalence	Tropics (more in cassava growing areas)	Tropics (developing countries – 50% young-onset DM)
4. Genetic factor	Not proven	Not proven
5. Usual onset	Slow, abdominal colic common	Intermediate
6. Build	Lean, emaciated	Emaciated
7. Insulin lack	++	++
8. Insulin resistance	++	+++
9. Insulin requirement	Moderate	High
10. Islet cell antibodies	Absent	Not proven
11. Ketosis	Not prone	Not prone
12. Sulfonylureas/ biguanides	Almost no response	Unresponsive
13. Common cause of death	Lack of proper treatment	Lack of proper treatment, infection

5. **Physical examination** – In a patient with diabetes, one should record height, weight, waist circumference, skinfold thickness, waist: hip ratio and BP. Detailed systemic examination including peripheral arterial pulsations to detect peripheral artery disease and carotid pulsations, neurological examination for cerebrovascular disease, fundus examination for retinopathy, skin examination particularly groins for fungus infection and scalp for furunculosis should be performed. Hepatomegaly is present in 20% of patients due to fatty infiltration.
6. **Investigations**
    - **a.** Blood glucose levels (fasting, 2 hours PPBS), renal, liver and lipid profile
    - **b.** Glycosylated Hb
    - **c.** Urine examination for urinary tract infection, albuminuria, microalbuminuria
    - **d.** Chest X-ray for cardiomegaly and tuberculosis
    - **e.** Plain X-ray abdomen for pancreatic calculi and calcification
    - **f.** Electrocardiogram and stress test for IHD
    - **h.** 2D-echocardiography for cardiomyopathy
    - **i.** Carotid and vertebral arteries Doppler for transient ischemic attack (TIA) and stroke
    - **j.** Doppler study of femoral and popliteal arteries for peripheral arterial disease
    - **k.** Ultrasound examination of kidneys for nephropathy
    - **l.** Computed tomography of abdomen for pancreatic calculi, calcification and liver pathology
7. **World Health Organization (WHO) diagnostic criteria for DM**
    - **a.** FPG < 110 mg/dl – Normal
    - **b.** FPG ≥ 110 mg/dl and <126 mg/dl – Impaired fasting glucose (IFG)
    - **c.** FPG ≥ 126 mg/dl – DM (provisional diagnosis) when same result is obtained on more than one occasion
    - **d.** Oral GTT
        - **i.** 2 hPG < 140 mg/dl – Normal glucose tolerance
        - **ii.** 2 hPG ≥ 140 mg/dl and <200 mg/dl – Impaired glucose tolerance (IGT)
        - **iii.** 2 hPG ≥ 200 mg/dl – Provisional diagnosis of DM (must be confirmed by retesting on the subsequent day)

(FPG = Fasting plasma glucose, 2 hPG = 2 hours postglucose)

The prognostic significance and outcome (i.e. accuracy) are same whether the FPG level is greater than 126 mg/dl or 2 hPG is greater than 200 mg/dl (i.e. DM). Hence, in clinical practice, FPG is now mostly preferred because of the ease, convenience and low cost to the patients.

The new American Diabetic Association criteria (2004) differ slightly from WHO diagnostic criteria. These are as follows:

- **a.** FPG < 100 mg/dl – Normal fasting glucose
- **b.** FPG > 100 mg/dl and <126 mg/dl – Impaired fasting glucose (IFG)

Rest same as WHO classification

8. **Examination of a patient with DM (Fig. 7.29)**
    - **a. General examination**
        - **i.** Obese, thin
        - **ii.** Bronzed or waxy skin, stria
        - **iii.** Pallor, pigmentation, bruising
        - **iv.** Edema feet
        - **v.** Xanthelasmas, xanthomas
        - **vi.** Fungal infection (Intertrigo, nail, oral candida)
        - **vii.** Amputation(s), foot ulcers, gangrene (diabetic foot), necrobiosis lipoidica diabeticorum

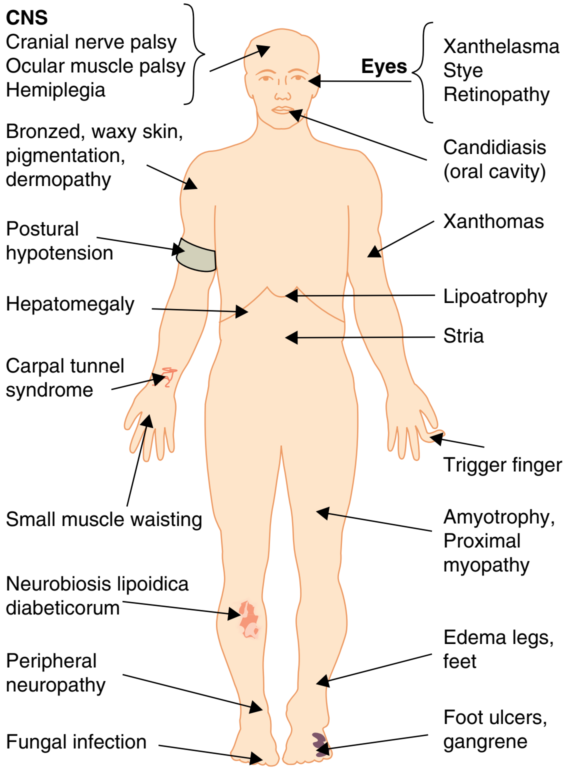
CNS
Cranial nerve palsy
Ocular muscle palsy
Hemiplegia
Bronzed, waxy skin, pigmentation, dermopathy
Postural hypotension
Hepatomegaly
Carpal tunnel syndrome
Small muscle waisting
Neurobiosis lipoidica diabeticorum
Peripheral neuropathy
Fungal infection
Eyes
Xanthelasma
Stye
Retinopathy
Candidiasis (oral cavity)
Xanthomas
Lipoatrophy
Stria
Trigger finger
Amyotrophy, Proximal myopathy
Edema legs, feet
Foot ulcers, gangrene

Figure 7.29 Clinical features in diabetes mellitus.

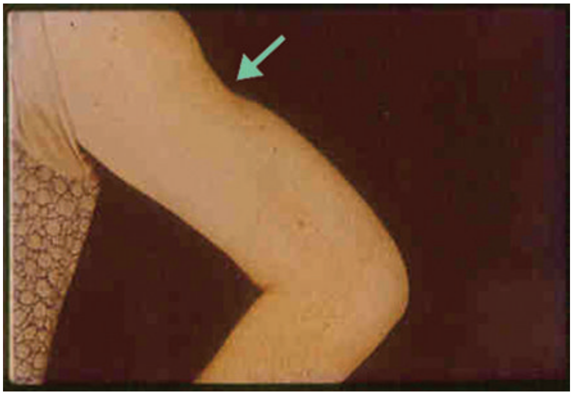

Figure 7.30 A case of diabetes showing lipodystrophy due to repeated insulin injections.

- **viii.** Lipodystrophy (due to repeated insulin injections; Fig. 7.30)

b. **Cardiovascular system**
- **i.** Peripheral pulses, carotid pulsations, carotid bruit
- **ii.** Blood pressure – Supine, sitting, standing for postural hypotension (autonomic neuropathy)
- **iii.** Jugular venous pressure
- **iv.** Cardiomegaly, S3 S4 gallop, murmurs, pericardial rub
- **v.** Sternotomy scar (coronary artery bypass graft surgery)

c. **Respiratory system** – Crackles (infection, LVF)

d. **Gastrointestinal system/abdomen** – Oral thrush, hepatomegaly, lipoatrophy (due to insulin injections), distended bladder

e. **Central nervous system** – Peripheral neuropathy, carpal tunnel syndrome, amyotrophy, hemiplegia, cranial nerve palsies, ataxia

f. **Eyes** – Visual acuity, ocular movements, pupillary reactions, hypertensive retinopathy, diabetic retinopathy

Complications of DM

Acute complications

1. Diabetic ketoacidosis (DKA)
2. Hyperosmolar nonketotic diabetic coma (HONC)
3. Lactic acidosis (LA)
4. Hypoglycemic coma (due to therapy)
5. Infections

Diabetic ketoacidosis

It was a common cause of death in IDDM before insulin therapy. Since insulin discovery, the mortality and morbidity have considerably reduced. It is more common in IDDM but can occur in NIDDM (with relative lack of insulin) in the presence of infections and stress.

Diabetic ketoacidosis presents with hyperglycemia, glycosuria, elevated plasma ketones, ketonuria, acidosis, dehydration, drowsiness and hypotension. Usual sequence of events is infection, reduced food intake, skipping or reducing insulin dose.

Both insulin deficiency and increase in counter hormones, particularly glucagon, are important factors in DKA. Counter regulatory hormones such as glucagon, cortisol, catecholamines and GH along with insulin deficiency lead to rise in plasma levels of free fatty acids (FFA) as well as glycerol, amino acids, lactates and glucose. Ketogenesis occurs due to accelerated β-oxidation of excess FFA derived from uncontrolled lipolysis. In healthy persons, ketones released from the liver are taken up by peripheral tissues for oxidation and generation of energy. In DKA, ketone production exceeds the utilization resulting in increase in ketone bodies in blood and ketonuria.

a. **Clinical features** – Patient presents with thirst, polyuria, weakness, muscle cramps, nausea, vomiting, abdominal pain, acidotic labored breathing (Kussmaul's breathing) with fruity odor, dehydration (dry tongue, sunken eyes), drowsiness, confusion and coma. Pulse is of poor volume, and BP is low.

b. **Investigations** – Urine shows glucose and ketone bodies; blood reveals hyperglycemia, ketonemia, aminoacidemia, lipemia, hyponatremia, hyperkalemia or normal K levels and reduced plasma bicarbonates. Plasma osmolality is increased. Level of consciousness correlates better with osmolality than with glycemia or acidosis. Higher the osmolality, deeper is the coma. Electrocardiogram and chest X-ray examination should be performed.

One may suspect acute abdomen due to pain in abdomen and vomiting. Elevated glucose and ketone levels along with glucosuria and ketonuria distinguish the two.

c. **Management**

  i. Preferably admit patient to an ICU, monitor vital signs and the level of consciousness and connect patient to the monitor to record ECG, pulse and BP
  ii. Monitor glucose (hourly), urine sugar, ketones, serum ketones, electrolytes, creatinine, calcium, phosphorus and blood gases
  iii. Insert Ryle's tube, catheterize the patient
  iv. Maintain intake, output chart
  v. Establish an IV line and correct fluid deficit. Initially, administer 1 liter 0.9% isotonic saline intravenously fast, followed by 1 liter/hourly till the volume deficit is corrected. In patients with healthy heart, fluid is given at a rate of 5–10 ml/Kg per hour over the first 1–3 hours. Later, when serum Na+ level is greater than 155 mEq/l, hypotonic saline (0.45%) is substituted. The rate of fluid administration is adjusted according to the cardiac and renal status and the degree of dehydration. Blood pressure and urine output indicate adequacy of fluid replacement. Total fluid replacement may take up to 24 hours.
  vi. Insulin – Bolus of 10–15 units of human Actrapid insulin (HAI) followed by continuous infusion of HAI in normal saline (125 units of HAI in 250 ml normal saline) at the rate of 5–10 units/hour to achieve a decrease of 50–75 mg/hour in blood glucose level. The dose of insulin can be increased if adequate response is not achieved. Fast reduction of glucose level (greater than 100 mg/hour) can induce encephalopathy. The rate of insulin infusion is reduced to 1–2 units/hour when anion gap is corrected and serum bicarbonate level is greater than 15 mEq/L. IV insulin is switched to subcutaneous injection when patient starts oral feeds.
  vii. Five percent IV glucose is infused when the blood glucose level is brought down to 250 mg/dl. Simultaneously, insulin is reduced to 0.05 units/kg/hour to avoid hypoglycemia.
  viii. Potassium – Hypokalemia should be prevented as it can result in fatal cardiac arrhythmia. IV glucose and insulin pushes K+ intracellularly. Unless hyperkalemia (S.K.+ >6.0 mq/l) is present, K+ is added to IV fluids and is administered at a rate of 10–20 mEq/litre. If hypokalemia is present at the start of treatment, the rate of K+ administration can be 40 mEq/liter or more, K+ is given as potassium chloride initially and later as potassium phosphate. Monitor ECG during K+ administration (see Chapter 10 pg 319).
  ix. Bicarbonate replacement is not necessary routinely. Its indications are
    - Shock or coma which does not respond to IV fluids
    - Severe acidosis (pH less than 7.1) unresponsive to fluid therapy
    - Lactic acidosis complicating DKA
    - Lactic acidosis a
    - Serum HCO_3 less than 5 mEq/l
    - Severe hyperkalemia (life-threatening)
    - Cardiac or respiratory dysfunction due to DKA
    - Bicarbonate when required, it is given as 88 mEq in a liter of hypotonic (0.45) saline over 1–2 hours but it should not be given as bolus.
  x. Routine replacement of phosphate and magnesium is not necessary. Phosphate if

required is given as K+ salt. Monitor for hypocalcemia.

xi. Treat with antimicrobials in the presence of infection.

Hyperosmolar nonketotic diabetic coma (HONC)

1. **Introduction**
   - **a.** It is a serious medical emergency
   - **b.** Characterized by plasma glucose level of 800–1200 mg/dl
   - **c.** Plasma osmolality is greater than 350 mOsm/l
   - **d.** There is no ketoacidosis, no ketonuria
   - **e.** Severe dehydration is present
2. **Etiology** – It usually occurs in middle aged and elderly patients with uncontrolled diabetes. There are several trigger factors such as phenytoin sodium, diuretics, glucocorticoids, propranolol, infections, cerebrovascular accident and administration of hyperosmolar fluids which may accentuate hyperglycemia, raise plasma osmolality and thereby lead to HONC.
3. **Clinical features** – Patients having polydipsia and polyuria for a variable period present with weakness, drowsiness progressing to coma. Patients are severely dehydrated. Breathing is shallow and rapid. Gastrointestinal symptoms are absent. Patient may have focal fits and variable neurological deficits, e.g. hemiplegia, dysphasia, which are reversible with proper treatment. Like DKA, level of consciousness correlates with plasma osmolality. Mortality is high.

For differential features of DKA and HONC, see Table 7.4.

Table 7.4 **Differential features of HONC and DKA**

Parameter	HONC	DKA
Plasma glucose (mg/dl)	800–1400	300–800
Plasma ketones	+	++++
Osmolality (mOSm/l)	330–350	<330
Blood pH	Normal	<7.2
Serum sodium	Elevated	Low
Serum potassium	Elevated/normal	Elevated/normal or low
Serum bicarbonate (mEq/l)	>16	<10
Blood urea	++	+
Hematocrit	+++	++

4. **Management principles**
   - **a.** Administer 2–3 liters of normal saline within first few hours
   - **b.** Later substitute with half normal saline
   - **c.** When plasma glucose level decreases to 250 mg, administer 5% dextrose solution to provide calories and free water
   - **d.** Low-dose insulin infusion (5–10 units per hour) intravenously from the beginning
   - **e.** Monitor blood sugar
   - **f.** Treat with antibiotics as indicated
   - **g.** Thromboembolic complications are common hence give prophylactic low-molecular weight heparin

Lactic acidosis

It is a relatively rare complication. Its prevalence has decreased following ban on phenformin. Lactic acidosis presents clinically with nausea, vomiting, epigastric pain and lethargy. Breathing is deep and labored and patient may loose consciousness. The criteria for diagnosis of LA are high levels of lactates (serum lactate greater than 5 mmol/l) and pH of 7.2 or below, but these abnormalities may sometimes be seen in DKA. Diagnosis of LA is by exclusion of other conditions that lead to acidosis.

Lactic acidosis should be considered in all seriously ill patients with DM. One must treat the primary condition and then correct hyperlactatemia and acidosis by infusing 3–5 liters of sodium bicarbonate (500–850 mmol). Tris-hydroxymethyl aminomethane (THAM) may be administered to counter sodium overload. Administration of glucose, thiamine and insulin as well as dicloacetate may help to activate pyruvate dehydrogenase and reduce production of lactate. Dialysis may be required in serious cases. Mortality is high (75%) when blood lactic acid level is 9 mmol/l or greater.

Hypoglycemic coma

Hypoglycemia is seen more commonly with insulin treatment than with oral hypoglycemic agents.

1. **Etiopathogenesis**
   - **a.** Most common cause of hypoglycemia is iatrogenic, i.e. drug induced. The dose of insulin or oral drug is more than the requirement.

- **b.** Skipped or unduly delayed or inadequate meals
- **c.** Vigorous exercise after insulin administration
- **d.** Liver cell dysfunction (due to poor glycogen stores)
- **e.** Fasting hypoglycemia in a healthy person suggests insulinoma
- **f.** Drugs (salicylates, phenylbutazone, methotrexate) potentiate the action of sulfonylureas
- **g.** Alcohol consumption along with oral hypoglycemic drugs may cause hypoglycemia

2. Clinical features – These are

- **a.** Due to sympathoadrenal stimulation
  - **i.** Sinus tachycardia
  - **ii.** Elevated BP
  - **iii.** Sweating
  - **iv.** Tremors
  - **v.** Nausea
- **b.** Due to neuroglycopenia
  - **i.** Headache
  - **ii.** Dizziness
  - **iii.** Seizures
  - **iv.** Confusion
  - **v.** Blurring of vision
  - **vi.** Fatigue
  - **vii.** Drowsiness
  - **viii.** Coma

Whipple's triad (hypoglycemia symptoms, low blood glucose and relief after glucose ingestion) is seen in insulinoma (β-cell tumor).

3. Investigations – Diagnosis is confirmed by low blood glucose level (less than 60 mg/dl).

In clinical practice, differentiation between hypoglycemic coma and hyperglycemic coma (DKA) is important (Table 7.5).

4. Treatment

- **a.** For conscious patient, give oral glucose and glucose biscuits. All patients with diabetes should carry glucose biscuits or sweets.
- **b.** For drowsy and comatose patient
  - Intravenous glucose, 25–50 ml of 50% dextrose stat followed by 5% or 10% dextrose infusion to maintain blood glucose above 100 mg/dl.
  - Intravenous glucagon 1 mg IM stat, if oral and IV glucose administration is not possible.

Table 7.5 Differential features between hypoglycemic coma and DKA

Parameters	DKA	Hypoglycemic coma
1. History	Skipping insulin/oral hypoglycemic drugs	Skipping meal
2. Onset	Slow	Quick
3. Pulse	Fast, low volume	Fast, bounding
4. Blood pressure	Low	Increased
5. Dehydration	Present	Nil
6. Eye ball tension	Reduced	Normal
7. Breathing	Rapid, deep, labored acidotic	Normal or shallow
8. Tremors	None	Present
9. Reflexes	Diminished	Brisk
10. Blood sugar	High	Low
11. Plasma acetone	Present	Negative
12. Plasma bicarbonate	Low	Normal
13. Urine glucose	++	+
14. Ketonuria	Present	Negative

5. Infections – In uncontrolled DM, various infections (bacterial, viral, fungal) occur. At high plasma glucose levels (FBS greater than 180 mg/dl), abnormalities of leukocyte function such as decrease in chemotactic aggregation and reduced phagocytic and bacterial activities of neutrophils are seen.

The common infections seen in diabetics are

- **a.** Cellulitis, multiple boils due to *Staphylococcus, Streptococcus* and Gram-negative bacilli
- **b.** Diabetic foot
- **c.** Carbuncle
- **d.** Pulmonary tuberculosis
- **e.** Osteomyelitis
- **f.** Otitis externa, otitis media, meningitis, brain abscess
- **g.** Rhinocerebral mucormycosis
- **h.** Renal papillary necrosis
- **i.** Cholecystitis

Infections are managed with appropriate antibiotics along with strict control of blood sugar with insulin.

6. **Chronic complications**
    a. Macroangiopathy
        i. Cardiovascular
        ii. Cerebrovascular
        iii. Peripheral
    b. Microangiopathy
        i. Nephropathy
        ii. Retinopathy
        iii. Neuropathy

Pathogenesis of chronic complications

In DM, hyperglycemia and hyperinsulinemia play a key role in causation of chronic complications. Owing to hyperglycemia, there is increased glycosylation of proteins and activation of polyol pathways, and these play a major role in the pathogenesis of chronic complications.

Hyperinsulinemia (endogenous and exogenous) is basically due to insulin resistance. The symptom complex of metabolic syndrome includes obesity, NIDDM, insulin resistance, dyslipidemia, hypertension and coronary artery disease. Experimentally, chronic infusion of insulin induced intima and media proliferation with deposition of cholesterol in the arterial wall. Hyperinsulinemia thus promotes macrovascular and microvascular complications.

1. **Macroangiopathy**
    a. **Cardiovascular complications** – There is a greater prevalence of coronary artery disease in diabetics. Patient may suffer from silent ischemia or suffer from angina of effort or unstable angina or AMI. Patient of AMI may have LVF, arrhythmias and cardiogenic shock.
    b. **Cerebrovascular complications** – Patient may suffer from TIAs or stroke. Patients with diabetes mellitus have greater prevalence of cerebrovascular episodes than Patients without diabetes.
    c. **Peripheral vascular disease** – Common in patients with diabetes. Approximately 30% of all lower limb amputations are carried out in patients with diabetes.
2. **Microangiopathy**
    A. **Retinopathy**
        a. *Early changes*
            i. Very early (detected on fluorescent angiography) Capillary leakage, neovascularization.
            ii. Early changes
                - Veins – dilatation, sheathing, beading.
                - Arteries – arteriolar narrowing, beading.
        b. *Background retinopathy in DM (Fig. 7.31)* Microaneurysms, hard exudates, hemorrhages, retinal, macular edema
        c. *Proliferative retinopathy in DM (Fig. 7.32)* Neovascularization, soft exudates (infarcts), vitreous hemorrhage, retinal detachment, fibrous patches, retinal rubeosis
    B. **Nephropathy** – Microalbuminuria should be looked for in every patient with diabetes. Blood urea and serum creatinine should be

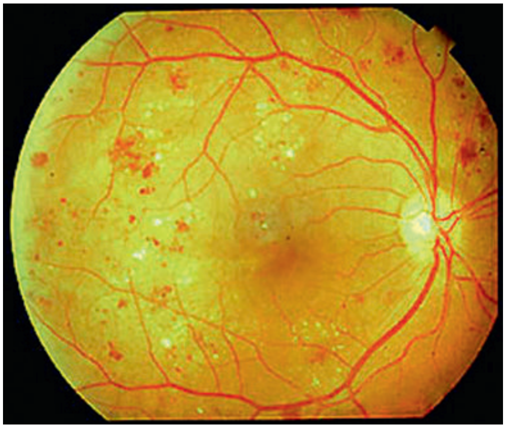

Figure 7.31 Diabetic retinopathy in DM showing dot blot hemorrhages, hard exudates and microaneurysms.

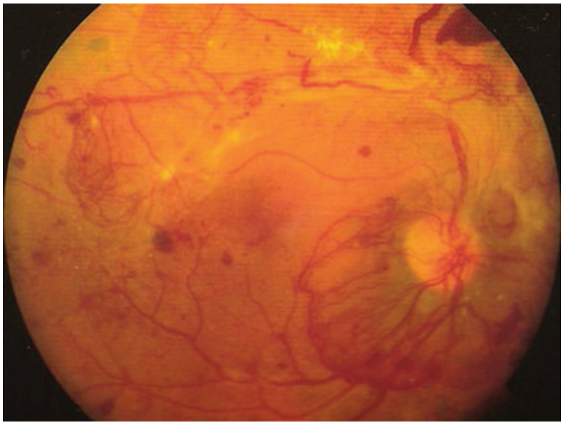

Figure 7.32 Diabetic retinopathy showing neovascularization.

monitored. Tight control of DM should be achieved.

C. **Neuropathy** – see Table 7.6.

Table 7.6 Types of diabetic neuropathy

1. Somatic
    a. Distal symmetric polyneuropathy
        i. It may be predominantly sensory
        ii. Sensorimotor
    b. Focal symmetric neuropathy
        i. Mononeuropathy – Cranial, spinal
        ii. Mononeuropathy multiplex
        iii. Radiculopathy
    c. Miscellaneous
        i. Proximal motor neuropathy
        ii. Entrapment neuropathy
        iii. Diffuse motor neuropathy
2. Autonomic
    a. Cardiac
    b. Gastrointestinal
    c. Pupillary
    d. Metabolic
    e. Urinary bladder dysfunction
    f. Erectile dysfunction

Viva voce

Q1. How does diabetic amyotrophy present?

- Seen in noninsulin-dependent, poorly controlled elderly diabetic patient
- Onset acute, unilateral, proximal muscle lower limb weakness
- Radicular pain, sensory symptoms ±
- May become bilateral
- Bladder, bowel symptoms may develop

Q2. What are the rheumatic manifestations of DM?

- Diabetic cheiroarthropathy (limited joint mobility syndrome) – It occurs in long-standing cases of DM (more in Type I than in Type II DM). Patient has stiffness of fingers and difficulty in forming fist. Patient is unable to approximate the palmar surfaces of fingers and palms resulting in the diabetic prayer sign (Fig. 7.33) and also unable to flatten the palm against the surface of table 'the table top test'.

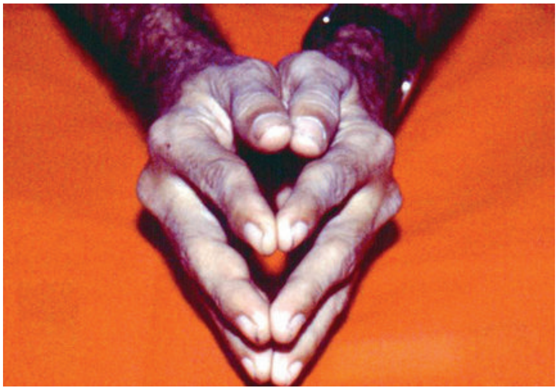

Figure 7.33 Diabetic cheiroarthropathy (diabetic prayer sign).

- Neuropathic arthropathy, osteolysis
- Adhesive capsulitis, calcific periarthritis of shoulder
- Reflex sympathetic dystrophy
- Diffuse idiopathic skeletal hyperostosis (DISH; Fig. 7.34)
- Carpal tunnel syndrome
- Dupuytren's contracture
- Algodystrophy
- Hyperostoses
- Osteoarthritis

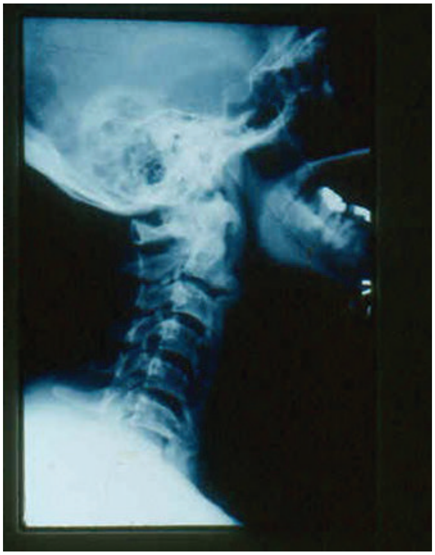

Figure 7.34 Diffuse idiopathic skeletal hyperostosis.

Chapter 8

Hematology and oncology

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HEMATOLOGY

1. **Introduction** – Blood contains three types of cells: red blood cells (RBCs), white blood cells (WBCs) and platelets. Anemia occurs either due to the decrease in the number of RBCs or due to the decrease in the concentration of the hemoglobin (Hb) in the RBCs. The most important cause of anemia is blood loss from gastrointestinal tract, menorrhagia and during labor. Anemia is confirmed when the Hb concentration is below the normal range (Box 8.1).
2. **Erythropoiesis** – It is controlled by erythropoietin that is produced by juxtaglomerular cells in kidneys in response to anoxia. Erythropoietin stimulates the erythropoietic stem cells of the

Normal blood indices in adult **Box 8.1**

	Male	Female
▪ RBC (per mm^3)	4.3–5.6	3.9–4.9
▪ Hb (g/dl)	13–16	12–14
▪ Packed cell volume	0.40	0.36
▪ Mean corpuscular volume (fl)	80–100	80–100

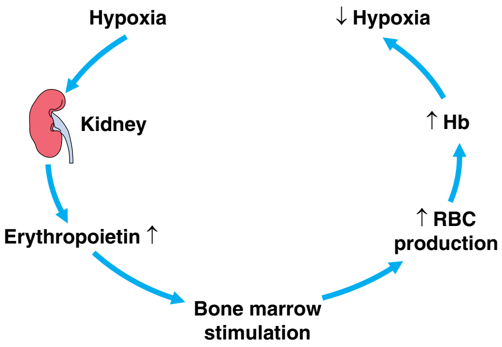

Figure 8.1 Secondary erythropoiesis.

bone marrow (BM), resulting in increased production of RBCs leading to rise in Hb and correction of hypoxia (Fig. 8.1).

3. **Etiological causes of anemia**
   a. Blood loss (commonest cause)
      - Acute bleeding (e.g. during labor)
      - Chronic blood loss (piles, gastrointestinal bleeding, menorrhagia, hookworm infestation)

   b. Deficiency disorders
      - Iron
      - Vitamin B12, folate
      - Proteins

   c. Anemia due to chronic systemic disorders (including infections)
      - Chronic renal failure (CRF)
      - Chronic liver disease (cirrhosis of liver)
      - Chronic infections (tuberculosis)
      - Malignancy
      - Chronic inflammatory disorders, e.g. rheumatoid arthritis

   d. Dyshematopoietic anemia
      - Leukemias, lymphomas, myelofibrosis
      - Multiple myeloma

   e. Hemolytic anemias (destruction is greater than production)

   f. Hypoplasia or aplasia of BM (aplastic anemia)

4. **Classification of anemias** – It is based on the size of RBCs (microcytic, macrocytic and normocytic) and Hb content
   a. Microcytic hypochromic anemia (mean corpuscular volume [MCV], mean corpuscular hemoglobin [MCH] are reduced). These are due to impaired heme synthesis, due to iron deficiency, sideroblastic anemia, pyridoxine (B6) responsive anemia, anemia of chronic diseases, lead poisoning or impaired globin synthesis (thalassemia)

   b. Macrocytic hypochromic anemia (MCV is raised, MCH is reduced relative to the size of RBC)
      - Megaloblastic anemia (Vitamin B12 or folate deficiency)
      - Nonmegaloblastic anemia (liver disease, myelodysplasia, hypothyroidism, chronic alcohol consumption)

   c. Normocytic normochromic anemias (MCV and MCH are normal) – Hemolytic anemia, aplastic anemia

   d. Dimorphic anemia (presence of both microcytes and macrocytes) due to combined iron and vitamin B12/folic acid deficiency

A case of iron deficiency anemia

Iron is an important component of Hb and of enzymes involved in tissue respiration and organ function. Total body iron content is 4 g in males and 3 g in females (70% as Hb, 25% as storage iron, 4–5% as tissue iron [myoglobin and iron-containing enzymes]). Circulating plasma iron is 0.1% of total body iron. Iron for Hb synthesis is obtained from transferrin-bound plasma iron. Iron is stored as ferritin and hemosiderin in reticuloendothelial cells of mainly BM, liver and spleen.

Iron requirements

Daily iron requirement is 1 mg in men, 2 mg in women and 3 mg during pregnancy. *Dietary sources of iron* are red meat, bone marrow, liver, egg yolk, green leafy vegetables, jaggery, dry fruits, apples and outer layer (husk) of cereals (brown bread has more iron than white bread). Iron is absorbed in duodenum and upper jejunum. The bioavailability of iron in cereals is poor as fiber and phytates interfere with its absorption. Dietary requirement with cereal-based diet is 2½ times more than that of nonvegetarian diet. Requirement is higher in growing children and in women during menses, pregnancy and lactation.

Prevalence and causes

Iron deficiency anemia (IDA) is the commonest deficiency worldwide. Prevalence is high in India, particularly in children and women. Most common mechanism of iron deficiency is chronic blood loss and dietary deficiency. Milk is a poor source of iron. In our country, weaning is delayed; hence, young children suffer from anemia if iron supplements are not given. Iron deficiency anemia is common in women because of menstrual blood loss (up to 30 mg per cycle) and increased demand during pregnancy (0.5–0.8 mg/day) and lactation (approximately 0.4 mg/day) (Box 8.2).

Causes of iron deficiency anemia **Box 8.2**

1. **Increased demand**
    - Postnatal growth spurt
    - Adolescent growth spurt
    - Menstruation
    - Pregnancy
2. **Chronic blood loss**
    - Hookworm
    - Bleeding piles
    - Menorrhagia
    - Peptic ulcer
    - Hiatus hernia
    - NSAID-induced gastric erosions
    - Carcinoma of stomach
    - Schistosomiasis
    - Inflammatory bowel disease
3. **Dietary deficiency**
4. **Malabsorption**
    - Celiac disease
    - Tropical sprue
    - Postgastrectomy

Clinical features

Onset is insidious as Hb decreases gradually. Pica and geophagia may be present, especially in children and women. Plummer–Vinson syndrome or Kelly-Patterson syndrome is due to a web at the pharyngoesophageal junction causing dysphagia. Hemic systolic murmur over pulmonary and aortic areas, cardiomegaly and edema feet are present in severe anemia (Fig. 8.2).

Investigations

1. Blood – Total RBC count, Hb and hematocrit are decreased. Peripheral blood smear shows hypochromic microcytes and anisocytes (Fig. 8.3).

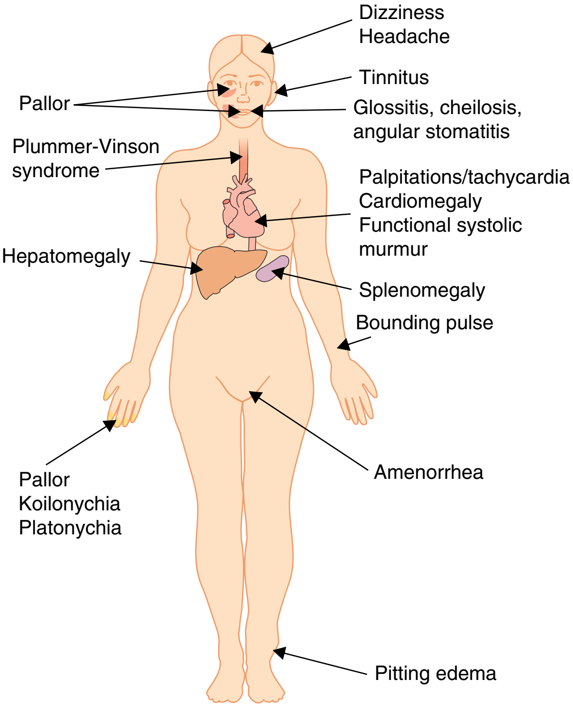
Dizziness
Headache
Tinnitus
Pallor
Glossitis, cheilosis, angular stomatitis
Plummer-Vinson syndrome
Palpitations/tachycardia
Cardiomegaly
Functional systolic murmur
Hepatomegaly
Splenomegaly
Bounding pulse
Amenorrhea
Pallor
Koilonychia
Platonychia
Pitting edema

Figure 8.2 Clinical features of IDA.

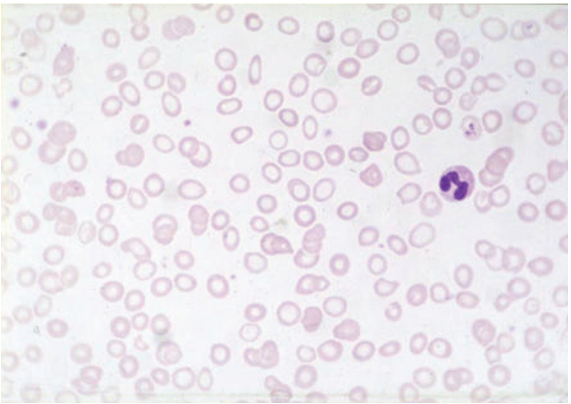

Figure 8.3 IDA – Peripheral smear showing hypochromic microcytes and anisocytes.

2. Bone marrow shows micronormoblasts and low iron stores (hemosiderin is low or absent).
3. Low serum iron, increased total iron binding capacity (TIBC), low transferrin saturation and low ferritin. Serum iron level decreases when stored iron is exhausted. Serum ferritin levels decrease before serum iron levels (Table 8.1).

4. Increased red-cell distribution width (RDW) is an index of the heterogeneity of red-cell size. It is more in IDA than in thalassemia minor in which all cells are small.
5. Examination of stool for worms and occult blood.
6. Other investigations depend upon the underlying cause.

Table 8.1 **Iron kinetics**

Parameter	Normal value	IDA
• Serum iron (ug/dl)	90–160 (M) 70–150 (F)	<35
• Serum TIBC (ng/dl)	250–400	>400
• Transferrin saturation (%)	20–50	<10
• Serum ferritin (ng/ml)		
Males	20–250	<10
Females	15–20	

Causes of microcytic hypochromic anemia

1. Iron deficiency anemia
2. β-thalassemia
3. Anemia of chronic disease
4. Sideroblastic anemia
5. Myelodysplastic syndrome
6. Atransferrinemia

Table 8.2 – Differential diagnosis

Table 8.2 **Differential diagnosis of important microcytic hypochromic anemias**

Parameter	IDA	β-thalassemia trait	Anemia of chronic disease	Sideroblastic anemia
• Serum iron	↓	Normal	↓	↑
• Serum ferritin	↓	Normal	↑	↑
• TIBC	↑	Normal	↓	Normal

Management

- Treatment of the underlying cause.
- Diet includes liberal intake of green leafy vegetables, apples, dates, nuts, red meat and liver. However dietary iron alone cannot correct iron deficiency due to poor availability of iron.
- Correction of iron deficiency by replacement (parenteral or oral). Oral iron is preferred and given as a single dose (100 mg/day). With 2-months treatment, Hb should return to normal. (Expected rise of Hb – 0.7–1.0 g/wk on iron supplementation.) With iron supplementation, maximum reticulocyte response occurs within 7–10 days after iron replacement begins. Iron should be given for 6 months to replenish iron stores. Ferrous salts are preferred. All the salts are absorbed equally; however, addition of ascorbic acid, succinic acid and fructose increases iron absorption. Food and antacids may reduce absorption, and hence, prefood dosing is preferred. Iron in the form of Hb has no advantage over elemental iron and is expensive.
- Side-effects of iron therapy are gastrointestinal disturbances (nausea, epigastric pain, constipation, diarrhea). Reduction of dose helps as side-effects are dose-related.
- Indications for parenteral iron are – a) intolerance to oral iron, b) severe anemia during last trimester of pregnancy, c) chronic blood loss where oral iron is inadequate to correct the anemia, d) chronic renal failure with iron deficiency.
- Iron dextran is suitable for intramuscular or intravenous injection. Total dose of iron requirement can be calculated from Hb% and plasma iron levels, and given as intravenous infusion in a single sitting.

  Total iron dose = $(2.38 \times \text{wt} \times D) + 1000$ mg for iron stores, where wt. is body weight in kg and D is the deficit of Hb in gm (15-patient's Hb). Before using iron dextran, sensitivity should be tested preferably by small intravenous test dose.
- Iron–sorbitol–citric acid is given only as intramuscular injection.
- Side-effects of parenteral iron are fever, arthralgia, nausea, vomiting, backache, chest pain, skin rashes, hypotension, angioneurotic edema, and lymphadenopathy.
- In severe anemia, either whole blood or packed red cells are transfused. To prevent fluid overload, furosemide is given before transfusion.

Prevention

- For dietary deficiency, fortification of food items such as common salt with iron salt.
- In endemic areas of hookworm infestation, improvement in personal and social hygiene

(avoiding defecation on roads, avoiding barefoot walking) and deworming treatment of community are necessary.
- Iron supplementation during first 3 years of life, during pregnancy and lactation.

A case of megaloblastic anemia

Introduction

Megaloblastic anemia is due to vitamin B12 and/or folate deficiency. In megaloblastic anemia, erythroid, myeloid and platelet precursors are affected. Megaloblastosis (large cell with large nucleus) is the result of defective (slow) DNA synthesis with continued RNA synthesis (dyspoiesis). Anemia is associated with leukopenia or thrombocytopenia. Bone marrow shows megaloblasts, giant metamyelocytes and giant megakaryocytes. Dyspoiesis increases intramedullary cell death (ineffective erythropoiesis), resulting in hyperbilirubinemia and hyperuricemia.

Metabolism of vitamin B12

- Daily requirement is 1 mg.
- Total body store of vitamin B12 is 5 mg (major portion in liver).
- Serum level of vitamin B12 is 200–600 pg/ml. In pernicious anemia, serum B12 is less than 100 pg/ml
- Intrinsic factor (IF; gastric glycoprotein) facilitates intestinal absorption of ingested vitamin B12 in the terminal ileum.
- Vitamin B12 is attached to transcobalamin II (a carrier protein) within the ileum and then transported to liver.

Causes of vitamin B12 deficiency

1. **Nutrition**
    - Low intake of meat and liver (strict vegetarians, chronic alcoholics). Meat and liver are good sources of vitamin B12
    - Poor absorption
    - Prolonged use of H2 receptor blockers
2. **Intrinsic factors deficiency**
    - Atrophic gastritis
    - Gastrectomy
    - Pernicious anemia
    - Defective transport (transcobalamin II deficiency)
3. **Diseases of terminal ileum**
    - Sprue (tropical or nontropical)
    - Ileocecal tuberculosis
    - Crohn’s disease
    - Infiltrative diseases of ileum (lymphoma, granuloma)
    - Ileal resection
4. **Competition for B12**
    - Fish tapeworm infestation
    - Bacterial overgrowth, e.g. blind loop syndrome.
5. **Drugs which inhibit B12 action**
   Colchicine, para-aminosalicylic acid, biguanides, neomycin, antineoplastic and immunosuppressive drugs

Causes of folic acid deficiency

1. Low intake of vegetables (elderly, chronic alcohol intake, overcooking, poverty, dietary fads). Green vegetables (e.g. spinach, asparagus, green beans) are good sources of folic acid.
2. Poor absorption – sprue (tropical, nontropical), celiac disease, Crohn’s disease
3. Decreased utilization – (dihydrofolate deficiency, vitamin B12 deficiency, alcohol)
4. Increased loss (hemodialysis, congestive cardiac failure, liver and kidney diseases)
5. Increased demand
    - Physiological (infants and growing children, pregnancy, lactation)
    - Pathological (hemolytic anemia, sideroblastic anemia, myeloproliferative disorders, leukemias, malignancy, extensive psoriasis, hyperthyroidism)
6. Drugs which inhibit folic acid action (phenytoin sodium, primidone, phenobarbitone, methotrexate, pyrimethamine, pentamidine, phenformin, trimethoprim and sulfa drugs).

Folate metabolism

- Daily requirement is 100 ng/d.
- Total body store is 5 mg.
- Serum folate level is 5–20 ng/ml.
- RBC folate level is 180–600 ng/ml.
- It is mainly absorbed in jejunum.
- Circulates as 5-methyltetrahydrofolate, loosely bound to albumin. It is converted to tetrahydrofolate intracellularly.

Megaloblastic anemia unrelated to folic acid/vitamin B12 deficiency

Drugs causing impairment of DNA metabolism
- 6-mercaptopurine, azathioprine (purine antagonists)

- 5-fluorouracil, cytosine arabinoside (pyrimidine antagonists)
- Other drugs (acyclovir, zidovudine, hydroxyurea, cyclophosphamide, arsenic)

Clinical features

Vitamin B12 deficiency

- Symptoms appear after variable time (3–12 years) of B12 deficiency – usual symptoms are dyspepsia, constipation, diarrhea, tiredness
- Pallor, mild jaundice (lemon yellow color of skin), smooth atrophic glossy pale tongue, angular stomatitis, skin pigmentation, purpura (secondary to thrombocytopenia)
- Neurological manifestations (subacute combined degeneration, peripheral neuropathy, optic atrophy and dementia)

Folate Deficiency

- Symptoms appear within a few weeks of development of deficiency.
- Pallor present but features such as glossitis and neurological manifestations are uncommon. Irritability, depression, insomnia, forgetfulness and anorexia may occur.

Investigations

1. **Megaloblastic anemia secondary to vitamin B12 deficiency**
   a. Blood
      - Low Hb (4–9 g/dl), MCV greater than 100 fl, high RDW, normal MCH and MCHC
      - Low reticulocyte count
      - Moderate leukopenia, and thrombocytopenia
      - Peripheral smear – Macrocytes, poikilocytes, ovalocytes, hypersegmented neutrophils (Fig. 8.4), megaloblasts and Howell–Jolly bodies may be seen (Fig. 8.5) in some cases.

   b. Bone marrow
      - Erythroid hyperplasia – with megaloblastosis (Fig. 8.6), concomitant iron deficiency may mask erythroid megaloblastosis.

   c. Biochemical abnormalities – Evidence of vitamin B12 deficiency
      - Serum vitamin B12 less than 100 pg/ml (normal 200–600 pg/ml)

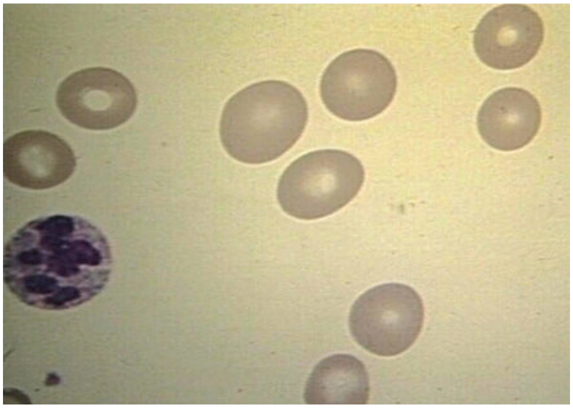

Figure 8.4 Megaloblastic anemia – peripheral smear showing macro-ovalocytes and hypersegmented polymorph.

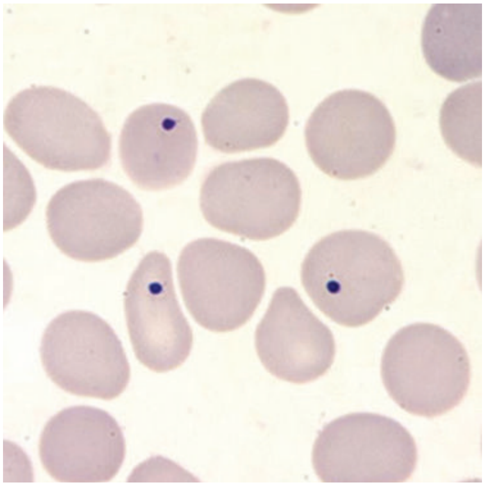

Figure 8.5 Peripheral smear in a case of megaloblastic anemia showing Howell–Jolly bodies.

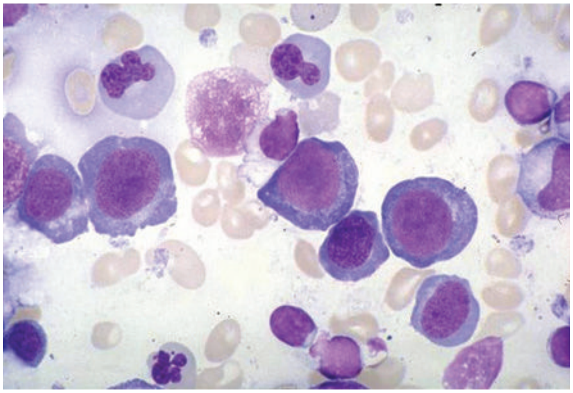

Figure 8.6 Megaloblastic anemia – BM showing megaloblasts.

    - Normal serum folate
    - Positive Schilling test
    - Intrinsic factor antibodies
    - Unconjugated hyperbilirubinemia, increased stercobilin, decreased serum haptoglobin (evidence of dyserythropoiesis)
    - Increased serum LDH (due to ineffective erythropoiesis)
    - Increased serum ferritin (greater than 300 ng/ml)
    - Methylmalonic aciduria (a very sensitive test of vitamin B12 deficiency)

2. **Megaloblastic anemia secondary to folate deficiency**
    - Blood and BM changes same as in vitamin B12 deficiency
    - Serum folate less than 3 ng/ml (normal 5–20 ng/ml) and RBC folate less than 160 ng/ml, normal RBC folate 180–600 ng/ml
    - Serum vitamin B12 lower limit normal
    - Elevated serum LDH
    - Increased excretion of formiminoglutamate in urine
    - Villous atrophy on jejunal biopsy

Principles of management

1. **Vitamin B12 deficiency**
    - Diet (not applicable to vegetarian) to include meat and liver.
    - Hydroxycobalamin (1000 μg) – Deep intramuscular injection (biweekly) until hematologic abnormalities are corrected. Folic acid is not to be given unless vitamin B12 deficiency is corrected as it may lead to fulminant neurologic deficit.
    - With treatment, BM becomes normoblastic, reticulocyte count rises, leukocyte and platelet counts return to normal (within a week).
    - Maintenance dose of 1000 μg of vitamin B12 is given, once a month for rest of life.
2. **Folate deficiency**
    - Diet to include green leafy vegetables.
    - Folic acid of 5–15 mg/day is given orally. In combined vitamin B12 and folic acid deficiency, first treat vitamin B12 deficiency. In the presence of vitamin B12 deficiency, folic acid given alone can precipitate neurological deficit. When B12 or folic acid deficiency is not clearly detected, it is better to treat with both vitamin B12 and folate.
    - Patients on methotrexate and other folic acid antagonists should receive folic acid orally (5 mg at least once per week).
    - Megaloblastic anemia caused by drugs that impair DNA synthesis does not respond to vitamin B12 or folic acid supplementation (refractory megaloblastic anemia).

A case of pernicious anemia

1. **Introduction**
    - Rare in India
    - Occurs in whites during middle age due to vitamin B12 deficiency
    - Linked with blood group A and HLA phenotypes
    - Starts as an autoimmune gastritis with damage to chief and parietal cells of the stomach. This leads to failure of IF and hydrochloric acid secretion, resulting in malabsorption of B12 (pernicious anemia) and achlorhydria
2. **Clinical presentation** – Insidious onset with presentation like megaloblastic anemia. In some cases, due to involvement of posterior columns, patient presents with subacute combined degeneration (Chapter 5, page 191). Splenomegaly may be present.
3. **Laboratory findings**
    - Low vitamin B12 levels
    - Elevated serum gastrin levels
    - Histamine-fast achlorhydria
    - Parietal cell antibody, blocking and binding antibodies to IF in serum and gastric juice
    - Atrophic gastritis confirmed by gastric biopsy

A case of hemolytic anemia

Red blood cells after release from BM remain in circulation for 120 days and are then removed by reticuloendothelial cells of liver, spleen and BM. In health, intravascular hemolysis is uncommon.

When there is excessive RBC destruction, BM becomes hyperplastic. Inability of BM to compensate for hemolysis results in anemia. In compensated hemolytic anemia, BM is able to compensate the excessive RBC destruction. Patients may develop conditioned folic acid deficiency with resultant megaloblastosis.

Causes of hemolytic anemia

Congenital (intrinsic)

1. **Hemoglobinopathies**
   a. Thalassemia (major and minor)
   b. Abnormal hemoglobins
      - Sickle Hb
      - Hb-C, Hb-D and Hb-E
2. **Membrane defects**
   a. Hereditary
      - Hereditary spherocytosis (HS)
      - Hereditary elliptocytosis
      - Congenital erythropoietic porphyria
   b. Acquired
      - Paroxysmal nocturnal hemoglobinuria (PNH)
      - Stomatocytosis
      - Hypophosphatemia
3. **Enzyme defects**
   a. Glucose-6-phosphate dehydrogenase (G6PD) deficiency
   b. Pyruvate kinase deficiency

Acquired

These are due to extracorpuscular (extrinsic) causes

1. **Immune mediated**
   - Autoimmune hemolytic anemia (AIHA)
   - Hemolytic disease of the new born
   - Mismatched blood transfusion
2. **Nonimmune mechanism**
   - Microangiopathic hemolytic anemia
   - March hemoglobinuria
   - Infections (malaria, Bartonella)
   - Burns
   - Chemical toxicity
   - Paroxysmal nocturnal hemoglobinurea
   - Traumatic (e.g. prosthetic valve)
   - Hypersplenism

Clinical presentation

- Salient features – Pallor, mild jaundice, hemolytic facies (in hemoglobinopathies) splenomegaly, pigment gallstones and leg ulcers.
- Hemolysis can be acute, chronic or episodic.
- Hemolytic crisis (acute, severe; complicates chronic hemolytic anemia) is uncommon. It is usually accompanied by fever, loin and abdominal pain, prostration and shock. There may be repeated episodes of aplastic crisis, often secondary to infection.

Investigations

1. To document excessive hemolysis (suspect in patients of anemia with reticulocytosis)
   - Unconjugated hyperbilirubinemia
   - Increased urinary urobilinogen
   - Elevated serum LDH
   - Decreased serum haptoglobin
2. Evidence of BM compensation
   - Erythroid hyperplasia of BM
   - Peripheral smear (reticulocytosis and macrocytosis)
   - Changes in skull and tubular bones (typical radiological changes of hemolytic anemia)
3. Red blood cell changes
   - Increased osmotic fragility (in spherocytosis)
   - Shortened red-cell survival (normal half-life, 28–32 days)
   - Morphological changes in RBC (sickle cells, spherocytes, elliptocytes, acanthocytes [spur cells], schistocytes [fragmented RBC]) (Box 8.3)
   - Peripheral smear – RBC morphology suggestive of hemolysis (Fig. 8.7)
   - Quantitative Hb electrophoresis
   - Red blood cell enzyme assays
   - Coombs' test, cold agglutinins, acid hemolysis or sucrose lysis test
4. Evidence of intravascular hemolysis
   - Hemoglobinuria
   - Hemosiderinuria
   - Methemalbuminemia
   - Decreased plasma haptoglobin and hemopexin

Peripheral smear abnormalities in hemolytic anemias **Box 8.3**

Abnormality	Diseases
■ Spherocytes	Hereditary spherocytosis
■ Target cells	Thalassemia major
■ Sickle cells	Sickle cell anemia
■ Agglutinated RBCs	Cold agglutinin disease
■ Nucleated RBCs (erythroblasts)	Thalassemia major
■ Heinz bodies	Oxidant stress (G6PD deficiency)
■ Acanthocytes	Spur cell anemia
■ Schistocytes	Microangiopathic hemolytic anemia

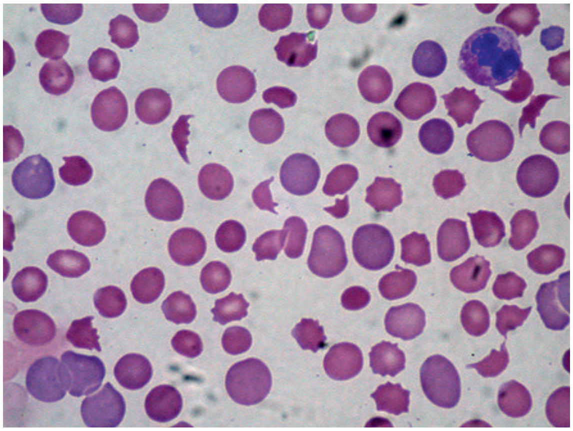

Figure 8.7 Hemolytic anemia – Peripheral smear showing microcytes, anisocytes, poikilocytes (tear drop cells), schistocytes (fragmented RBC) and acanthocytes (spur cells).

Hereditary spherocytosis

- Inherited as an autosomal dominant disorder
- Anemia, jaundice, pigment gallstones, splenomegaly, reticulocytosis
- Red blood cell fragility increased, peripheral smear shows spherocytes (Fig. 8.8)
- Coombs' test negative

Treatment

Splenectomy – Pneumococcal vaccine before splenectomy; postsplenectomy, oral ampicillin/penicillin given for prophylaxis.

Hereditary elliptocytosis

Peripheral smear – Elliptocytosis (Fig. 8.9)
Clinically resembles hereditary spherocytosis.
Majority treated symptomatically. Occasionally, splenectomy is required.

Glucose-6-phosphate dehydrogenase deficiency (potential cause for hemolytic crises)

- It is usually asymptomatic until certain drugs and infections cause oxidative stress with resultant hemolytic crisis.
- It is inherited as sex-linked; females are carriers.
- Hemolytic crisis (sudden onset of pallor, jaundice and hemolysis). Severe cases are managed by blood transfusion, intravenous fluids and diuresis.

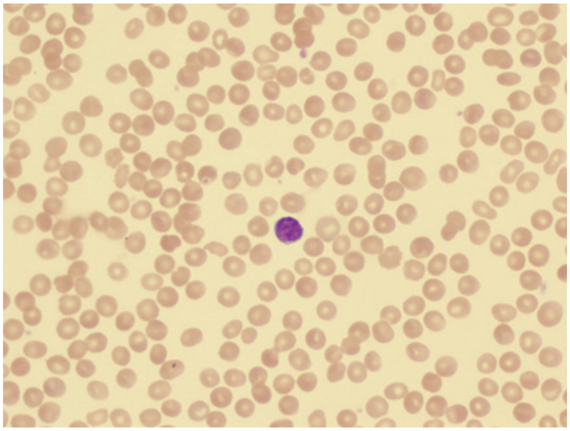

Figure 8.8 Hereditary spherocytosis – Peripheral smear showing spherical red cells (spherocytes).

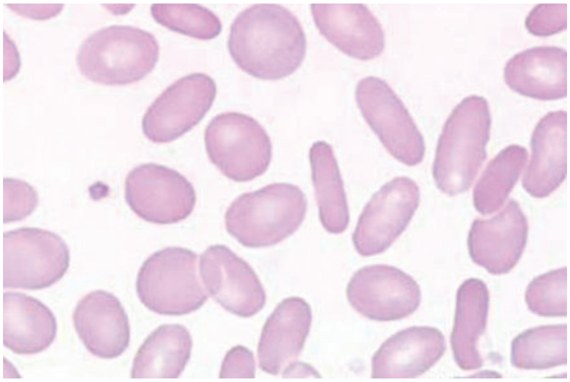

Figure 8.9 Hereditary elliptocytosis – Peripheral smear showing elliptocytes.

Drugs to be avoided in G6PD deficiency

- Sulfonamides (sulfacetamide, sulfamethoxazole, sulfanilamide, sulfapyridine, sulfasalazine etc)
- Primaquine, pamaquine and pentaquine
- Analgesics (acetanilide, phenacetin)
- Nitrofurantoin, nalidixic acid, chloramphenicol, dapsone, sulfones, thiazoles
- Fluoroquinolones (norfloxacin, ciprofloxacin)
- Doxorubicin, methylene blue, toluidine blue, niridazole, trinitrotoluene, some vitamin K derivatives.

Thalassemia

Introduction

Hemoglobin has two pairs of peptide chains (alpha and beta) with heme molecule attached to each peptide.

Fetal Hb is HbF (alpha 2 gamma 2). If it persists beyond fetal stage, it results in β-thalassemia. Adult Hb is 95% HbA (alpha 2 beta 2) and 5% HbA2 (alpha 2 theta 2).

Thalassemia is the most common gene disorder of Hb production, being common in tropics where falciparum malaria has been endemic. Thalassemia is characterized by defective Hb synthesis (decreased production of at least one globin polypeptide chain – beta, alpha, gamma, theta).

Types of thalassemia

1. Alpha-thalassemia (α chain production is reduced). Rare not important in clinical practice, HbF and HbA2 levels are normal.
2. Beta-thalassemia is important (β chain production reduced). It is of two types.
   a. Beta-thalassemia major (homozygotes) – (Cooley's anemia) – HbF is increased with mild increase of HbA2 and absence or severe reduction of HbA.
   b. Beta-thalassemia minor (heterozygotes) HbA2 is increased (6%).

A case of beta-thalassemia major (Cooley's anemia)

It occurs when both parents have thalassemia minor or trait. Anemia is severe with severe microcytosis, hypochromasia, erythroblastosis, and target cells in peripheral smear (Fig. 8.10). HbF is elevated and HBA is diminished or absent. It presents in early infancy with severe pallor, jaundice, failure to grow, severe anorexia and recurrent infections. Severe anemia leads to compensatory erythropoiesis due to increased production of erythropoietin resulting in BM expansion, which is seen as frontal bossing and prominent cheek bones (chipmunk facies) (Fig. 8.11), hepatosplenomegaly (often massive with secondary hypersplenism), pathological fractures of long bones and vertebrae. In some patients, extensive erythropoiesis results in formation of extramedullary erythropoiesis in liver, spleen, pelvis, skull and paraspinal regions. X-ray findings are diagnostic (Box 8.4).

Patients need repeated blood transfusions. There is increased iron load (hemosiderosis) due to increased absorption of iron from gut and repeated blood transfusions. It may prove fatal

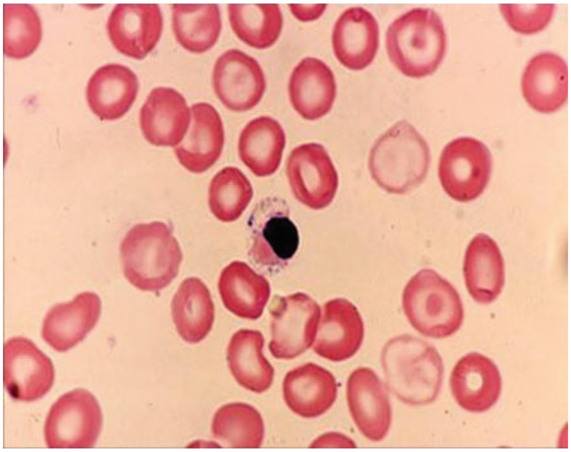

Figure 8.10 Peripheral blood film of a case of thalassemia major showing nucleated RBC, hypochromia, microcytosis and target cells.

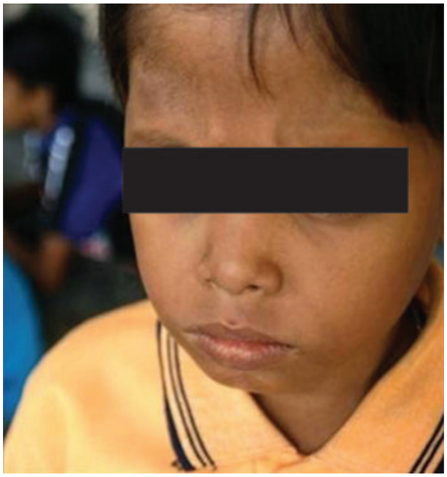

Figure 8.11 A case of β-thalassemia major showing frontal bossing and chipmunk facies.

X-ray findings in thalassemia major — Box 8.4

- Skull – Cortical thinning with widening of diploic space and a sunray appearance of trabeculae. Hair on end appearance (Fig. 8.12)
- Long bones – Widening of marrow space with patchy osteoporosis
- Vertebrae – Ground glass appearance
- Phalanges – Rectangular or biconvex
- Chest X-ray – Areas of extramedullary erythropoiesis in ribs and cardiomegaly (Fig. 8.13)

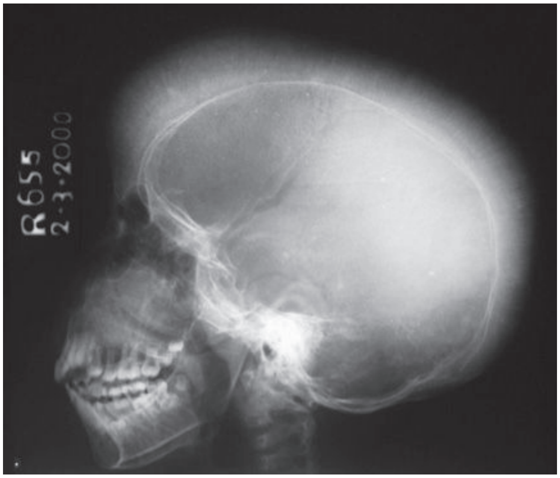

Figure 8.12 Skull X-ray showing hair on end appearance (thalassemia major).

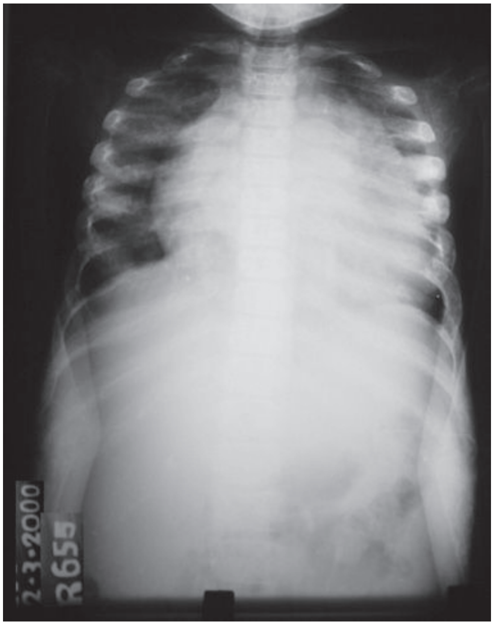

Figure 8.13 Chest X-ray showing cardiomegaly, ribs and scapular changes due to extramedullary erythropoieses (thalassemia major).

due to cardiomyopathy with CCF or arrhythmias. Hepatic siderosis leads to liver cell failure. Other manifestations are cholelithiasis and leg ulcers (Fig. 8.14). Puberty is delayed; patients may suffer from endocrinopathies, e.g. diabetes mellitus, hypothyroidism. All these complications are avoidable if timely hypertransfusion therapy along with chelation is instituted.

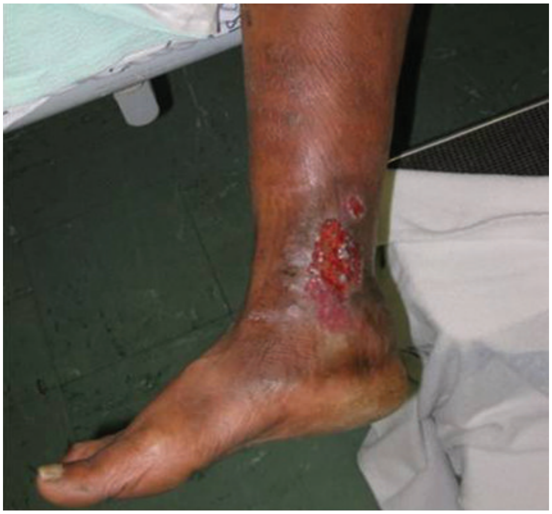

Figure 8.14 Leg ulcer in a case of hemolytic anemia.

Beta-thalassemia minor

It occurs when one of the parents has thalassemia trait. There is mild microcytosis, hypochromasia and few target cells (Fig. 8.15); HbA2 is raised. Prognosis is good.

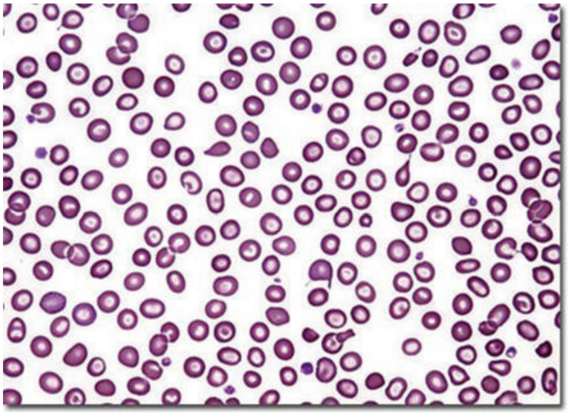

Figure 8.15 β-thalassemia minor – Peripheral smear showing microcytic hypochromic cells.

Management

- Major type – Hypertransfusion (RBC transfusion) along with iron chelation therapy (desferrioxamine) and folic acid supplements
- Bone marrow transplantation (BMT)
- Splenectomy for severe hypersplenism

- Genetic counseling to prevent marriages between thalassemics
- Minor type – Only folic acid supplementation is indicated
- Iron therapy contraindicated unless iron deficiency is documented

A case of sickle cell disease

Sickle cell disease is due to homozygous inheritance of a gene that leads to an aminoacid substitution in the Hb molecule (β-6 glutamine → valine), creating HbS due to point mutation. It is rare in whites, but common in black Africans. The disease presents during infancy and early childhood.

Clinically, it may be manifested as sickle cell anemia (homozygous [SS]) or sickle cell trait (heterozygous [AS]).

Trigger factors for sickling are –

- Hypoxia (low oxygen tension)
- Low pH
- Sluggish blood flow
- Pyrexia

When the blood is deoxygenated, sickling of RBCs occurs. This results in hemolysis, and the red cells coalesce blocking small vessels leading to infarction.

Presenting clinical features are pallor, jaundice, swelling of hands and feet, leg ulcers, infections, splenomegaly, necrosis of bones and kidney failure.

Patients of sickle cell disease may present with any of the following crisis.

a. Aplastic crisis – Triggered by parvovirus infection resulting in BM failure and low reticulocyte count.
b. Sequestration crisis – Spleen and liver get enlarged due to sequestration of RBCs leading to severe anemia, which can be fatal in infants. Later, due to repeated infarctions and fibrosis, autosplenectomy results.
c. Thrombotic crisis – Infection, dehydration and exposure to cold at high altitudes leads to thrombosis in various vessels presenting with neurological symptoms, acute abdomen, bone necrosis, retinopathy etc.
d. Hemolytic crisis – Uncommon.

Investigations

- Peripheral smear, sodium metabisulfite preparation, shows sickle cells (Fig. 8.16).
- Hb electrophoresis is confirmatory.
- Peripheral smear may show target cells, nucleated RBCs and Howell–Jolly bodies.

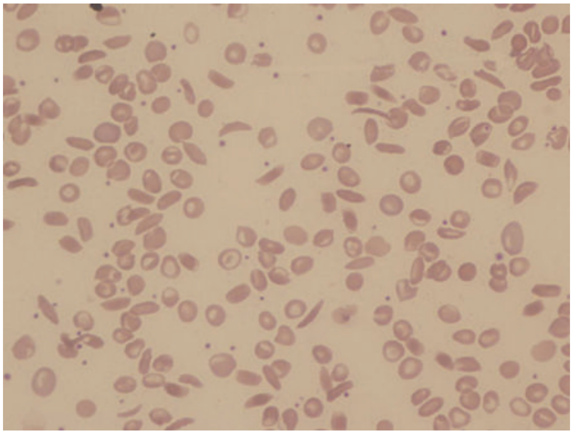

Figure 8.16 Sickle cell disease – Peripheral smear, sodium metabisulfite preparation, showing sickle cells. Also present are target cells.

Principles of management

- Antibiotics for infections
- Blood transfusion when Hb, packed cell volume (PCV) and reticulocyte counts drop
- Give IV fluids and analgesics for thrombotic crisis
- Oxygen 5 liters/minute during crisis
- Exchange transfusion with acute splenic sequestration, CNS complications, retinal lesions and priapism
- Red blood cell (packed) transfusion(s) in aplastic crisis
- Antisickling drugs such as hydroxyurea or butyrate compounds increase HbF synthesis/production
- Folic acid supplement, 1 mg/day. (It is also given for sickle cell trait.)
- Stem-cell transplantation can be curative but carries 5–10% mortality

A case of aplastic anemia

There is pancytopenia due to BM failure affecting all three cell types (erythrocytes, granulocytes and megakaryocytes).

Causes of aplastic anemia

1. Idiopathic
2. Drugs (either due to drug allergy or due to toxicity), chloramphenicol, sulfonamides, antithyroid drugs, phenytoin sodium, phenylbutazone, indomethacin, phenothiazines, gold, bismuth etc.
3. Radiation

4. Toxins – Insecticides (organic phosphates)
5. Infections (HIV, tuberculosis)
6. Familial aplastic anemia (Fanconi's anemia)
7. As a part of myelodysplasia. Some cases of aplastic anemia may progress to myelodysplastic syndrome.

Clinical presentation

Patient presents with tiredness, weakness, bleeding (ecchymoses, epistaxis, hematemesis) and infections (which may aggravate thrombocytopenia). On examination, patient looks pale with petechiae, bleeding gums, oral ulcerations and in later stages, splenomegaly. Liver and lymph node enlargement are uncommon.

Investigations

There is anemia (normocytic and normochromic), neutropenia, lymphopenia, and thrombocytopenia.

- Peripheral smear shows scanty WBCs and platelets with mild macrocytosis.
- Bone marrow – Shows scanty aspirated material with scanty granulocytes, predominance of lymphocytes, plasma cells and fat cells.

Principles of management

- Patients are more susceptible to infections. Prophylactic measures include antibiotics, antiseptic lotions for skin, gentle brushing of teeth, avoiding injuries, falls and intramuscular injections
- Give packed RBC, platelet infusions
- Prompt treatment of fever or infection
- Bone marrow transplantation – Treatment of choice in young patients
- Immunosuppressive drugs (cyclosporine A or cyclophosphamide) may be tried
- Corticosteroids may be tried

Hyperspleni sm

- Spleen destroys RBCs, WBCs and platelets. It is usually a mild and asymptomatic condition. White blood cell differential count is normal. Anemia is normocytic-normochromic. Reticulocytosis is usually present.
- The splenic enlargement is almost always due to other disorders, e.g. infections, congestive splenomegaly, inflammatory diseases, lymphoproliferative disorders etc.
- There is severe passive congestion of spleen, which results in sludging of blood and hypoxia, making cells vulnerable to phagocytic action of macrophages in the splenic pulp.
- Diagnosis is based on pancytopenia (or reduced levels of two blood cell elements in any combination), splenomegaly and hypercellular BM.

Treatment

- Treatment of underlying disease
- Splenectomy only if pancytopenia is significant and symptomatic (avoided as far as possible)
- Prophylactic vaccination for pneumonia, influenza, meningitis before splenectomy

A case of sideroblastic anemia

In sideroblastic anemia, incorporation of iron into heme does not take place. The excess iron gets deposited in the mitochondria of erythroblasts. The BM biopsy when stained with Prussian blue stain shows orthochromatic normoblasts with ring of blue granules surrounding the nucleus (ringed sideroblasts) (Fig. 8.17). The blue granules are iron-laden mitochondria. Sideroblasts are seen not only in sideroblastic anemia but also in myelodysplastic syndrome which is a refractory anemia. Sideroblastic anemia responds to pyridoxine. The usual pyridoxine responsive anemia is microcytic hypochromic and is due to diminished Hb synthesis. It is commonly mistaken for iron deficiency anemia.

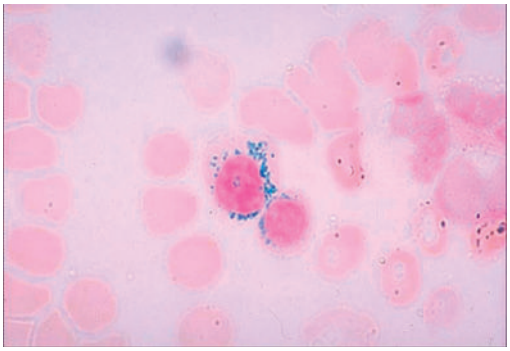

Figure 8.17 Sideroblastic anemia – BM showing an orthochromatic normoblast with a ring of blue granules (ringed sideroblast).

A case of anemia

1. **Presenting symptoms** – General weakness, tiredness, giddiness, syncope, ringing in ears, palpitations, breathlessness, edema feet, postural hypotension, congestive cardiac failure and dysphagia (due to esophageal web – Plummer–Vinson Syndrome.)
2. **Presenting signs**
   a. Pallor, large volume pulse (water hammer with severe anemia) and hemic systolic murmur best heard at base of the heart.
   b. In some cases, signs of CCF may develop.
   c. It may be possible to differentiate different types of anemia by the special features of each type (given below).

Type of anemia	Special features
1. Iron deficiency anemia (microcytic hypochromic)	Koilonychia or Platonychia, dysphagia (Plummer–Vinson syndrome), angular stomatitis, glossitis
2. Megaloblastic anemia	
• Vitamin B12 deficiency	Neurological features – neuropathy, subacute combined degeneration of cord; severe glossitis (red beefy tongue)
• Folic acid deficiency (megaloblastic)	Glossitis, no neurological deficit
3. Hemolytic	Lemon yellow skin due to anemia and mild jaundice; leg ulcers, splenic enlargement
4. Thalassemia major	Chipmunk facies; retarded growth, splenomegaly
5. Sickle cell anemia	Tower-shaped skull, small trunk and long arms, poor growth, leg ulcers, osteomyelitis, bony tenderness; autosplenectomy in adults

Viva voce

Q1. What are the causes of reticulocytosis?
- Therapeutic response to therapy with iron, B12 or folate
- Brisk erythropoiesis after blood loss
- Hemolytic crisis

Q2. When will you ask for reticulocyte count?
- To confirm the response to therapy of anemia by iron, vitamin B12 or folic acid. The reticulocyte count increases by day 7
- To assess response to erythropoietin
- To ascertain successful bone marrow transplant
- For diagnosis of BM depression when reticulocyte count is decreased (normal count, 0.5–2.5%)

Q3. What are the causes of raised erythrocyte sedimentation rate?
- Infections (acute and chronic [tuberculosis common cause])
- Inflammatory rheumatic diseases (rheumatoid arthritis, systemic lupus erythematosus systemic vasculitidis scleroderma, rheumatic fever)
- Anemia
- Malignant disorders (especially, lymphomas, colon cancer and breast cancer)
- Acute myocardial infarction
- Hypergammaglobulinemia, multiple myeloma, Waldenström's macroglobulinemia
- Miscellaneous (hyperthyroidism, hypothyroidism, CRF)
- Physiological (during menstruation, pregnancy, elderly)

Q4. What are the causes of low erythrocyte sedimentation rate?
- Congestive cardiac failure
- Polycythemia
- Congenital spherocytosis
- Hypofibrinogenemia
- Sickle cell disease

Q5. How do you carry out Schilling test?
One mg of radioactive B12 is given orally to the patient with concurrent administration and without concurrent administration of IF. Prior to the test, intramuscular injection of 1000 mg of vitamin B12 is given to saturate body stores. If IF increases the absorption, the test is positive and confirms the diagnosis of lack of IF due to pernicious anemia and gastrectomy. If not, other causes such as diverticular, blind loop or terminal ileal disease resulting in poor absorption of vitamin B12 may be present (intestinal malabsorption).

ONCOLOGY

Oncology is the study of malignant tumors. The term *cancer* covers a wide variety of malignant diseases. Here we shall focus on cancers of blood (leukemias) and reticuloendothelial and lymphatic systems (lymphomas). Liver and lung cancers are described in respective sections.

Before the discovery of cytotoxic drugs, physician's role in the management of malignancies was less than that of surgeons and radiotherapists; but with the development of newer chemotherapeutic drugs, physician (oncologist) plays an important role not only in the management but also in the palliative care of various malignant conditions. The salient features of various leukemias and lymphomas are described in brief.

A case of acute leukemia

There are two main types of acute leukemia: acute lymphoblastic leukemia (ALL) and acute myeloblastic leukemia (AML).

1. **Clinical features** – There is accumulation of blast cells in the BM. They also appear in the peripheral blood. The course is rapid and fatal if not treated. Acute lymphoblastic leukemia occurs in children and old persons, whereas AML occurs amongst young adults and middle-aged persons.

   Patients present with fever, weakness, anemia, bleeding in the skin (ecchymosis, petechiae), bleeding from nose, gums, pain and tenderness of bones (due to marrow involvement), hepatosplenomegaly and lymphadenopathy (more common in ALL). Involvement of meninges causes headache, nausea, vomiting, papilledema and neurological deficit, particularly cranial nerve deficits.
2. **Investigations**
   - Low Hb and RBC counts
   - High WBC count (50,000–100,000/ul)
   - Peripheral blood film shows blast cells and other premature cells of myeloid or lymphoid series depending upon whether it is AML or ALL (Figs. 8.18 and 8.19) Myeloblasts may show Auer rods in few cells
   - Thrombocytopenia
   - Bone marrow is hypercellular with blast cells (lymphoblasts or myeloblasts) more than 30%, replacing normal cells (Fig. 8.20)
   - Owing to rapid turnover of cells, there is an increase in uric acid, alkaline phosphatase and LDH levels in the blood
   - Cerebrospinal fluid examination must be done in all ALL cases to evaluate CNS involvement
   - Renal profile to detect renal failure
   - Chest X-ray and chest computed tomography (CT) for mediastinal glands
   - Chromosomal studies
   - Immunophenotyping. Also define lineage type (B or T cells).

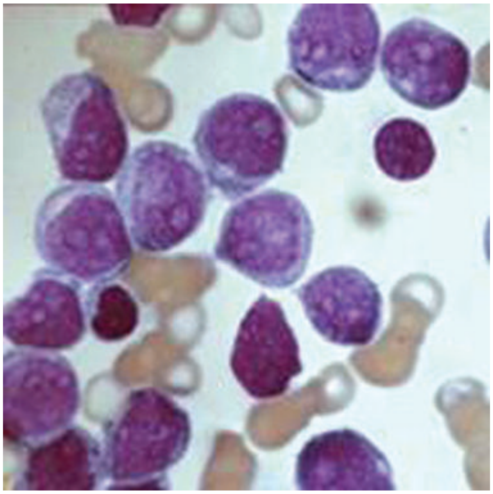

Figure 8.18 Acute myeloid leukemia – Peripheral smear showing predominant myeloblasts with few showing Auer rods.

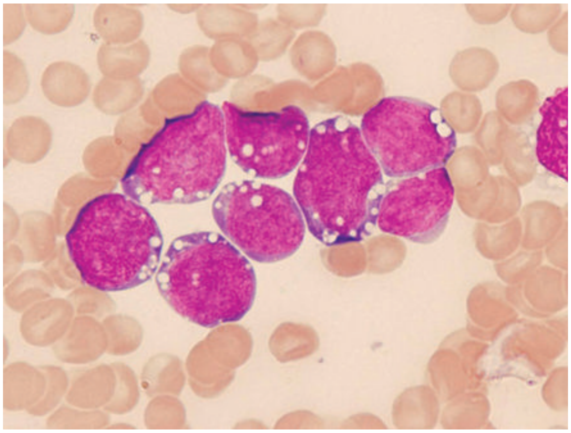

Figure 8.19 Acute lymphoblastic leukemia (Burkett's type) peripheral smear showing lymphoblasts.

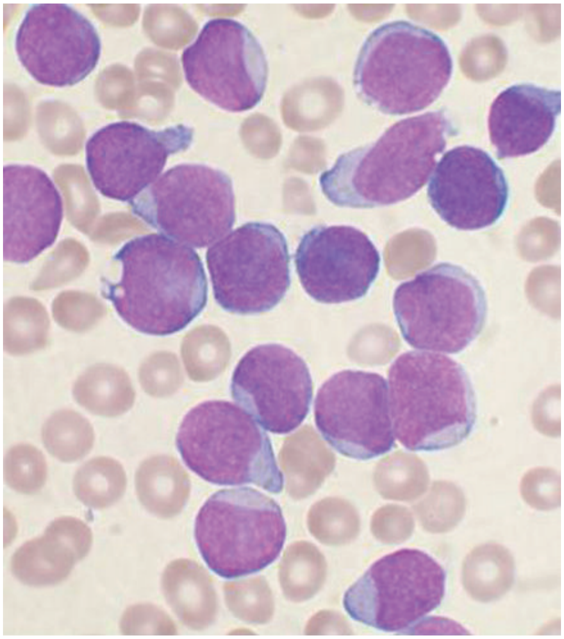

Figure 8.20 Bone marrow from a case of acute myeloid leukemia showing myeloblasts.

3. **Management**
    - To treat anemia and thrombocytopenia, initiate packed RBC and platelet transfusions
    - Antibiotics for treatment and prophylaxis
    - Chemotherapy

A case of chronic myeloid (myelocytic) leukemia

1. **Introduction**
    - A clonal disorder of pluripotent stem cell involving myeloid, erythroid, megakaryocytic and lymphoid cells. Normal stem cells are retained and can emerge after suppression of chronic myeloid leukemia (CML) clone with treatment. In most cases, CML progresses to an accelerated phase and finally blast crisis.
    - Approximately 90–95% of cases have a cytogenetic abnormality (reciprocal translocation between long arms of chromosomes 9 and 22). The translocated piece of chromosome 9 contains oncogene c-abl. This fuses with BCR gene on chromosome 22 with the formation of ABL–BCR fusion gene. This abnormal 22 chromosome is known as Philadelphia (PL) chromosome.
    - Exact cause is not known. Higher incidence is reported in survivors of atomic bomb. Radiation treatment may also be a risk factor.
2. **Clinical presentation**
    - Initial asymptomatic phase is diagnosed accidentally. Mostly seen in elderly (40–70 years); it presents with fever, night sweats, loss of weight and tiredness. Clinically, pallor, mild hepatomegaly, moderate to severe splenomegaly and sternal tenderness are present.
    - Lymph node enlargement (not common in early stages) and skin involvement are markers of poor prognosis. Accelerated phase is characterized by anemia and thrombocytopenia. Granulocytes may be defective. Blast crisis is characterized by myeloblasts (60% of patients), lymphoblasts (30% of patients) and megakaryoblasts (20% of patients). Additional chromosomal abnormalities are frequent. Blast cell tumors may develop at extramedullary sites. This stage resembles acute leukemia.
3. **Diagnosis**
    - High WBC count (greater than 50,000 to few lakhs/mm^3 in symptomatic patients);
    - Low Hb, normocytic normochromic anemia
    - Thrombocytosis initially. Platelet count decreases later;
    - Peripheral smear shows full range of myeloid series – promyelocytes, myelocytes and metamyelocytes greater than 30% and myeloblasts less than 10% (Fig. 8.21);
    - Eosinophilia, basophilia
    - Bone marrow is hypercellular, full with myeloid series as seen in peripheral smear (PS). Philadelphia chromosome is present in majority (90%) of cases. Myelofibrosis is seen in some cases;
    - Low leukocyte alkaline phosphatase;
    - Elevated serum vitamin B12 and LDH levels.
4. **Differential diagnosis**
    - Myeloid leukemoid reaction is characterized by the absence of eosinophilia, basophilia and with increased leukocyte alkaline phosphatase.
    - Myelofibrosis – diagnostic features are nucleated RBC, tear drop RBC, anemia and thrombocytopenia.
5. **Treatment**
    a. **Symptomatic/palliative**
        - Interferon gamma (IFN gamma)

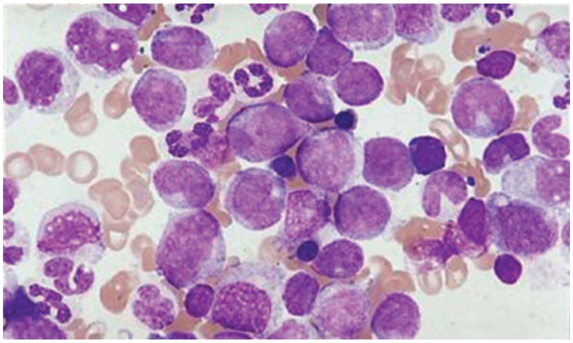

Figure 8.21 Chronic myeloid leukemia – Peripheral smear showing myeloid series in different stages of maturation (promyelocytes, myelocytes, metamyelocytes).

  - Hydroxyurea (0.5–2 g/day for induction and maintenance)
  - Splenic radiation in refractory cases
  - Splenectomy to alleviate abdominal discomfort or when treatment cannot control hypersplenism. It may relieve thrombocytopenia and reduce blood transfusion requirements
  - Busulfan, hydroxyurea and IFN-γ are used to treat ABL–BCR negative patients, relapsed patients and blast crisis. These achieve only symptomatic relief. Hydroxyurea (dose of 0.5–2.0 g) is given as per response. Busulfan is not recommended these days

b. Curative

  - Imatinib (drug of choice) – It achieves complete clinical and cytogenic remission of Ph chromosome +ve CML. Also useful in accelerated phase. Imatinib inhibits the specific tyrosine kinase due to ABL–BCR gene. In case of resistance to Imatinib, newer agents such as dasatinib and nilotinib are promising alternatives
  - Bone marrow transplant – Eradication of leukemic clone with chemotherapy and radiotherapy, followed by allogenic BM transplant to restore normal hemopoiesis. However, with the emergence of therapy with novel agents such as imatinib and newer dasatinib and nilotinib, the need for BMT is on decline.
  - Blast crisis – Treatment is similar to acute leukemia; regimen depends upon type of transformation (lymphoblastic or myeloblastic). Increasing the dose of imatinib or replacement with dasatinib is also recommended.

A case of chronic lymphatic leukemia

1. Introduction

- Chronic lymphatic leukemia (CLL) accounts for 25% of all leukemias. It is the most common type of leukemia in the west with long life span. It is less common in India.
- It originates from a clone of mostly CD51 B lymphocytes. These have abnormally long life span.

2. Clinical presentation

- It is more common in males than females and the elderly (60 years and above).
- It is often asymptomatic and diagnosed on routine testing.
- There is gradual increase in total body mass of lymphocytes that accumulate in BM, blood, lymph nodes, liver and spleen. In late stages, BM is saturated till it fails.
- Generalized lymphadenopathy, mild hepatosplenomegaly and anemia are common initial findings.
- Late in the disease, due to progressive BM involvement, anemia, neutropenia, thrombocytopenia and decreased Ig production develop.
- In late stages, there is increased susceptibility to infections (bacterial, viral, fungal), which is due to granulocytopenia and hypogammaglobulinemia. Often patient presents with infections, particularly chest infections and fever.
- There is an increased susceptibility to autoimmune diseases, autoimmune hemolytic anemia and a mildly increased risk of developing other cancers.

3. Investigations

- Peripheral smear (Fig. 8.22) and BM are packed with lymphocytes (greater than 30%). Absolute lymphocyte count is greater than 5000/mm^3.
- Autoimmune hemolytic anemia in 15% cases. Hemoglobin is low.
- Immune thrombocytopenia in 2%.
- Hypogammaglobulinemia.
- Occasionally, monoclonal band is seen on protein electrophoresis.

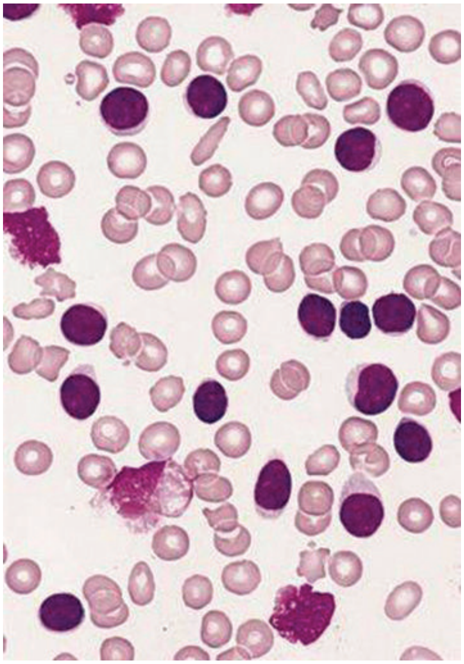

Figure 8.22 Chronic lymphocytic leukemia – Peripheral smear showing small lymphocytes.

- Beta cell type CLL is the most common subtype (expresses CD5 and CD23 surface markers).

4. **Staging of chronic lymphocytic leukemia**
   a. **Rai staging**
      - Stage O – Lymphocytosis (absolute lymphocytes greater than 10,000/mm^3 in blood and greater than 30% in BM
      - Stage I – Lymphocytosis plus lymphadenopathy
      - Stage II – Lymphocytosis with splenomegaly or hepatomegaly plus lymphadenopathy
      - Stage III – Lymphocytosis with anemia (Hb less than 11 g/day) or hematocrit (less than 33%) plus lymphadenopathy plus splenomegaly or hepatomegaly may be present
      - Stage IV – Lymphocytosis with thrombocytopenia (less than 10×10^9/liter) with lymphadenopathy plus splenomegaly or hepatomegaly may be present

   b. **Modified Rai staging as per risk**
      - Low risk – Stage O
      - Intermediate risk – Stages I and II
      - High risk – Stages III and IV

5. **Diagnosis** – CLL is confirmed by high lymphocyte count in peripheral smear and by BM infiltration with lymphocytes
6. **Differential diagnosis**
   - Reactive lymphocytosis of viral infections (atypical lymphocytes are present in peripheral smear)
   - Lymphocytic lymphoma
   - Sezary syndrome
   - Hairy cell leukemia
7. **Prognosis**
   - Median survival is 10 years, patients with Rai stage O to II may survive up to 20 years without any treatment and often die of unrelated diseases.
   - Second malignancy, especially skin cancer may develop.
8. **Treatment**
   - Specific treatment is not indicated in asymptomatic patients. Supportive treatment includes transfusions, treatment of infections with bactericidal antibiotics, gamma globulin for hypogammaglobulinemia with recurrent infections.
   - In symptomatic patients, specific treatment (given below) is indicated in Stage I with high lymphocyte count (greater than 100,000/mm^3) or with severe splenomegaly and lymphadenopathy.
9. **Specific treatment**
   - Chlorambucil (0.1–0.2 mg/kg BW) daily for 1–2 weeks each month combined with corticosteroids
   - Combination of cyclophosphamide, vincristine and prednisolone (CVP regimen) used particularly in chlorambucil resistant patients
   - Purine analogs – Fludarabine, 2-chloro deoxyadenosine (2cdA) and 2-deoxy coformycin (DCF) interfere with purine degradation and are highly lymphocytotoxic
   - Monoclonal antibody – Rituximab and alemtuzumab are highly effective and can be combined with chemotherapy
   - Steroids for AIHA and idiopathic thrombocytopenic purpura (ITP)
   - Local irradiation
   - Bone marrow transplant (allogenic) – attempted in small number of cases

As CLL is an indolent disorder and the response is not encouraging, hence risks of BMT are not worth taking.

A case of multiple myeloma

1. **Introduction**
    - Most common plasma cell dyscrasia.
    - A clonal disorder of plasma cells secreting only one type of immunoglobulin – (monoclonal immunoglobulin) IgG in approximately 55%; IgA in approximately 20%, IgD in 1% and light chains in approximately 15–20%.
    - As abnormal immunoglobulins are produced without antigenic stimulation, there is decreased production of normal immunoglobulins with increased susceptibility to infections.
    - Hyperplasia of plasma cells fills the BM to the extent that bone is eroded causing pathological fractures. Osteoclastic activity of myeloma cells is due to osteoclast activating factor (cytokines) released by myeloma cells. This leads to osteoporosis or osteolytic lesions. Common sites are pelvis, ribs, skull and spine.
    - In two-third of cases, light chains either κ or λ appear in urine (Bence Jones proteins).
    - Bence Jones proteinuria, hyperuricemia and amyloidosis lead to renal damage. Calcium, mobilized from bones, causes hypercalcemia, hypercalciuria and nephrocalcinosis.
    - Hyperviscosity syndrome due to abnormal immunoglobulins presents as anorexia, weakness, neurological and retinal abnormalities. Invasion of BM by plasma cells results in myelophthisic anemia, thrombocytopenia and leukopenia.
    - In majority, plasma cells can be seen in peripheral blood (buffy coat preparation).
2. **Clinical manifestations**
    - Commonly presents between 50 and 70 years of age. Men are more commonly affected
    - Twenty percent are asymptomatic and are detected during routine health check up
    - Anemia is common
    - Insidious onset – Backache, body ache, arthralgias, pathological fractures, local tumors and infections (mostly chest) are other features
    - Neurological manifestations include compression myelopathy, amyloid peripheral neuropathy and carpal tunnel syndrome
    - Hepatomegaly (40%), splenomegaly (20%), lymphadenopathy and involvement of other organs in some cases
    - Due to immunodeficiency, herpes zoster and pneumonia are common
    - Renal failure due to extensive cast formation in the tubules, interstitial fibrosis and tubular atrophy
    - Secondary amyloidosis in 10%, especially in patients with Bence Jones proteinuria
    - Hyperviscosity symptoms, abnormal bleeding, polyuria, polydipsia (secondary to hypercalcemia)
3. **Investigations**
    - Blood – normocytic normochromic anemia, neutropenia, thrombocytopenia, coagulation defects, hyperviscosity features and peripheral smear showing rouleaux formation (Fig. 8.23)
    - X-ray of bones – osteoporosis or osteolytic lesions in skull (Fig. 8.24), vertebrae, pelvis, ribs, clavicle, localized swellings over bones and pathological fractures
    - Erythrocyte sedimentation rate – Very high (often greater than 100 mm/hour)
    - Elevated serum creatinine and blood urea levels
    - High serum calcium
    - Increased serum β_2 microglobin levels (reflect plasma cell mass)
    - Protein electrophoresis for M band in serum and urine
    - Immunofixation studies for serum proteins
    - Urine for Bence Jones proteins
    - Bone marrow examination shows plasma cells with eccentric nucleus which constitute

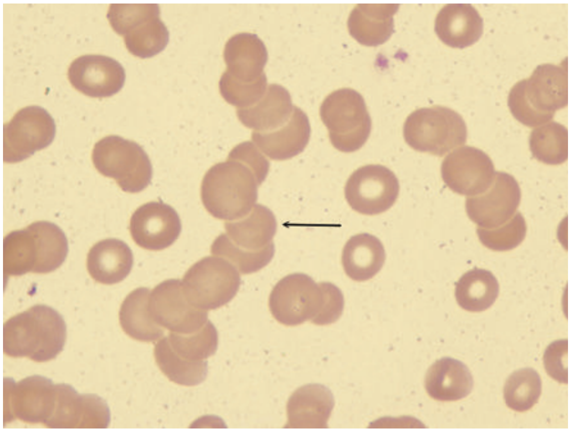

Figure 8.23 Peripheral smear from a case of multiple myeloma showing rouleaux formation.

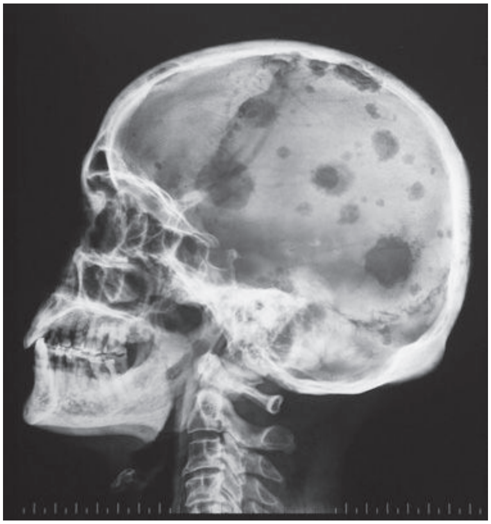

Figure 8.24 Multiple myeloma – Punched-out areas in skull.

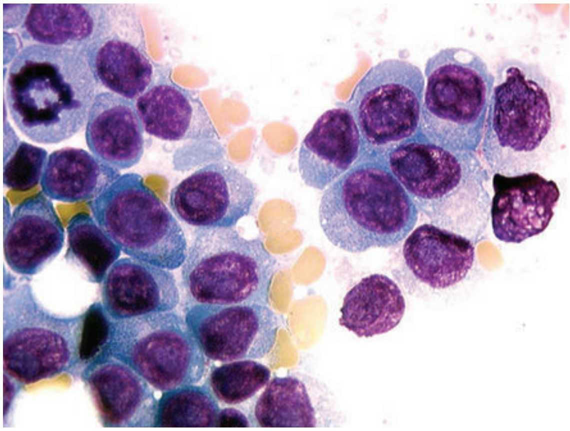

Figure 8.25 BM in a case of multiple myeloma showing plasma cells with an eccentric nucleus.

greater than 10% of total nucleated cells (Fig. 8.25)

Suspect multiple myeloma if the following features are present

- Unexplained bone pains (particularly at night)
- Elevated serum proteins
- Hypercalcemia
- Renal insufficiency
- Anemia

4. **Diagnosis**
   - Typical clinical features
   - High erythrocyte sedimentation rate (often greater than 100 mm/hour)
   - Bence Jones proteinuria, M band on serum immunoelectrophoresis of serum and concentrated urine
   - Punched-out lesions on X-ray of bones
   - Bone marrow examination is diagnostic – Increased plasma cells greater than 10% is diagnostic
   - Protein and immunoelectrophoresis for confirmation and typing of myeloma by determining the type of immunoglobulin (IgG [50%], IgA [25%], IgD [1%])
   - Light chain myeloma in 15–20% (κ or λ Bence Jones protein), M band in serum usually present in 80–90%. Free light chain assay is now available
   - Nonsecretory myeloma (very rare)
5. **Prognosis**
   - Multiple myeloma runs a chronic course with 3–4 years survival
   - Poor prognostic signs – Blood urea greater than 80 mg/dl, Hb less than 7 g/dl, low albumin, high levels of M protein, elevated β2 microglobulin, diffuse bone lesions and hypercalcemia
6. **Standard treatment**
   - Intermittent courses of melphalan (0.15 mg/kg/day), OD, with prednisolone (60 mg) daily after breakfast for 4 days. Repeated once a month. Evaluated at 3–6 months.
   - Cyclophosphamide (oral 1.5 mg/kg/day) improves general health and median survival.
   - If the response to standard treatment is not good, combination of vincristine, adriamycin, doxorubicin and dexamethasone is tried.
   - Thalidomide combined with melphalan and prednisolone is the standard care for most patients, especially the elderly. Bortezomib added to melphalan and prednisolone is highly effective and recommended treatment nowadays.
   - Autologous, peripheral stem-cell transplantation is advocated as curative measure for patients less than 70 years of age with stable renal, pulmonary, cardiac and hepatic functions, and stable disease.
   - Allogenic BMT for patients less than 50 years is optional in high-risk or resistant cases; survival is up to 5–10 years.
   - Bisphosphonates are highly effective for treatment of bone lesions.

7. **Supportive treatment**
    - Prompt treatment for infections. Prophylactic antibiotics are not indicated. All patients should receive pneumococcal and influenza vaccines.
    - Allopurinol is used for the prevention of hyperuricemia.
    - Prevention of renal complications of hyperuricemia with hydration, alkalization of urine with sodium bicarbonate and a small dose of furosemide to achieve urine output of 2 l/day.
    - Plasmapheresis for hyperviscosity syndrome.
    - Treatment of complications such as fractures and spinal cord compression.
    - Treatment of osteoporosis – Ambulation, pamidronate or other bisphosphonates.
    - Avoid contrast studies in dehydrated state as it can precipitate renal failure.
    - Packed RBCs for symptomatic anemia.
    - Erythropoietin in patients with renal failure when Hb does not increase with chemotherapy.
    - For bone pain – Analgesics, radiation therapy and bisphosphonates.

A case of myelofibrosis (primary myelosclerosis)

1. **Introduction** – There is severe BM fibrosis with compensatory myeloid metaplasia of liver and spleen causing gross hepatosplenomegaly.
2. **Clinical features** – Patients present with severe weakness, lethargy, loss of weight, aches and pains over muscles, joints and gross splenomegaly. Patients die of severe infection, thrombotic episodes or bleeding.
3. **Investigations**
    - Peripheral smear shows macrocytic anemia, tear drops and leukoerythroblastic picture.
    - High serum uric acid is seen.
    - Bone marrow is either dry tap or shows fibrous tissue (Fig. 8.26).
4. **Principle of management** – Blood transfusion, androgen therapy, folic acid, corticosteroids, hydroxyurea, splenectomy, spleen radiation (small doses) and bone marrow transplant.

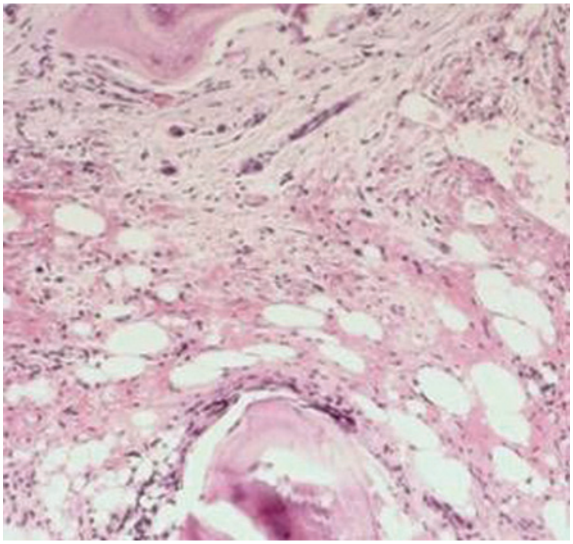

Figure 8.26 BM trephine biopsy showing replacement of marrow with fibrosis in a case of primary myelofibrosis.

Viva voce

Q1. In which conditions is neutrophil alkaline phosphatase increased?
- Essential thrombocythemia
- Polycythemia vera
- Myelosclerosis

Q2. In which condition is neutrophil alkaline phosphatase decreased?
- Aplastic anemia
- Chronic myeloid leukemia

Myeloproliferative disorders

This term includes conditions where there is proliferation of the precursors of myeloid series of cells WBC (CML; described earlier), RBC (polycythemia), and platelets (primary thrombocythemia).

Polycythemia vera

There is an absolute increase in RBC mass (independent of erythropoietin), which is responsible for clinical symptoms. There is increased viscosity and vascular stasis, leading to thrombotic episodes. Because of stagnation and deoxygenation of blood in peripheral blood vessels, patient has a plethoric and cyanotic hue color of the skin. Patients suffer from headache, giddiness, high blood pressure, angina, cerebrovascular symptoms, abdominal symptoms like hematemesis, melena and pain in left hypochondriac region (splenic infarction) or lumbar region (renal infarction).

Splenomegaly is present in majority of patients. Late complications include failure of erythropoiesis, thrombocytosis, myelofibrosis and acute leukemia.

Investigations

- Red blood cell count = 7–10 million/ul
- Hemoglobin more than 18 g/dl
- Packed cell volume more than 60%
- White blood cell count more than 12,000/ul (in the absence of infection)
- Platelet counts more than 400,000/ul
- Elevated neutrophil alkaline phosphatase
- High uric acid
- Elevated serum B12
- Depleted iron stores
- Bone marrow hypercellular with increase in erythropoiesis, granulopoiesis and megakaryocytopoiesis (panmyelosis)

Secondary polycythemia

It is due to two main mechanisms.

1. Hypoxia, resulting in increased production of erythropoietin

   Causes of hypoxia

   - Pulmonary diseases
   - Cyanotic congenital heart diseases
   - High altitude
   - Chronic smoking
   - Gross obesity, pickwickian syndrome causing sleep apnea
   - Abnormal hemoglobins
2. Inappropriate erythropoietin secretion by tumors of kidney, liver, uterus – hypernephroma, renal cysts, hepatoma, uterine fibroma, pheochromocytoma.

Management

- Venesection (300–500 ml of blood removed at one sitting). It is repeated every other day till hematocrit decreases to less than 45%, subsequently repeated as required.
- Hydroxyurea
- IF-α-2b if hydroxyurea fails
- Allopurinol during chemotherapy to counteract hyperuricemia
- Radioactive phosphorous (32P)

Essential (primary thrombocythemia)

Clinical features

Platelet count is very high (greater than 600,000/ul). Platelets are abnormal morphologically. Patient may suffer from thrombosis or bleeding.

Approximately one-third of the patients are asymptomatic. Presenting features are thrombotic episodes, hematemesis or melena, vascular headaches, paresthesias, burning feet. Splenomegaly is common but liver enlargement is rare. Life expectancy is normal. Less than 2% of patients develop leukemic transformation.

Investigations

- Platelet count greater than 600,000/ul
- Normal RBC, hematocrit and Hb% levels
- Adequate iron stores
- Philadelphia chromosome (Ph1) absent

Management

In asymptomatic patients, aspirin dose of 75 mg/day and close observation are adequate. For symptomatic patients, therapies used are

- Busulfan or hydroxyurea (25 mg/kg/day [orally])
- Radioactive phosphorous (2.5–3 mc/m^2) intravenously every 6 months for 2 years
- In severe cases with very high platelet count, IFN-α in a dose of 2–4 MU/m^2 subcutaneously, daily or on alternate days.
- Leukemic transformation is treated like acute myeloid leukemia

Lymphomas

Lymphomas are broadly divided into two types: Hodgkin's lymphoma (Hodgkin's disease) (30%) and non-Hodgkin's lymphoma (70%).

A case of Hodgkin's disease

This is a rare form of cancer (1% of all cancers). It is more common in males and is seen in all age groups with a peak occurrence in adolescents and elderly. Exact etiology is not known, Epstein–Barr virus infection may be a possible etiological factor.

Reed–Sternberg cells (large multinucleated giant cells having mirror image nuclei) are the hallmark of Hodgkin's disease. The lymph node structure is disorganized due to accumulation of lymphocytes, histocytes, plasma cells, eosinophils and fibroblasts. The relative proportion of Reed–Sternberg cells along with lymphocytes and sclerosis and fibrosis are taken into consideration while classifying Hodgkin's disease into four types:

- Lymphocyte depleted
- Lymphocyte predominant
- Mixed cellularity
- Nodular sclerosis.

Nodular sclerosing type is the most common type in developed countries and mixed cellularity type is common in developing countries.

Clinical features

The onset is insidious. Patients present with painless lymph node enlargement, cervical being the commonest (60%) site. The glands are rubbery, nontender and not matted. Patients usually have constitutional symptoms like fever, loss of appetite and weight, night sweats and itching. Pel–Ebstein type of fever (see Fig. 1.14) may be present in some patients. Hepatosplenomegaly is seen in advanced cases. Mediastinal lymphadenopathy may be present with features of mediastinal compression syndrome (see Chapter 4).

Clinical staging (Ann Arbor classification) (Table 8.3)

Table 8.3 **Clinical staging of Hodgkin's disease (Ann Arbor classification)**

Stage	**Clinical involvement**
I	Involvement of a single lymph node region (I) or extralymphatic site (E)
II	Involvement of two or more lymph node regions (II) or an extralymphatic site and lymph node regions on the same side (above or below) the diaphragm (IIE)
III	Involvement of lymph node regions on both sides of the diaphragm with (IIE) or without (III) localized extralymphatic involvement or involvement of the spleen (IIIS) or both (IIISE)
IV	Diffuse involvement of one or more extralymphatic tissues, e.g. liver or bone marrow. The lymphatic structures include lymph node, spleen, thymus, Waldeyer's ring, appendix and Payer's patches.

Each stage is subdivided into A or B categories based on the absence or presence of systemic symptoms (fever, night sweats and weight loss).

Investigations

These are done to assess the extent of involvement of lymph nodes and extralymphatic organs. These include

Complete blood counts (polymorphonuclear leucocytosis, lymphopenia, eosinophilia, pancytopenia with BM invasion)

- Chest X-ray
- Computed tomography or positron emission tomography of abdomen and pelvis
- Bone marrow biopsy
- Lymph node biopsy to confirm the diagnosis (Fig. 8.27)
- Liver biopsy if hepatomegaly is present
- Radioisotope bone scan
- Gallium scan.

Differential diagnosis

- Non-Hodgkin's lymphoma
- Chronic tuberculous lymphadenitis
- Sarcoidosis
- Bronchogenic carcinoma
- Histoplasmosis

Management

Hodgkin's disease is treated with either radiotherapy, chemotherapy or both.

Radiotherapy is indicated in (a) Stage IA and IIA disease with three or less areas of involvement; (b) after chemotherapy, radiotherapy is targeted to sites where there was original bulk disease; (c) radiotherapy is targeted to lesions causing compression symptoms.

Chemotherapy is indicated in

- Stage III and Stage IV disease
- All symptomatic patients
- Stage II with more than three areas of involvement

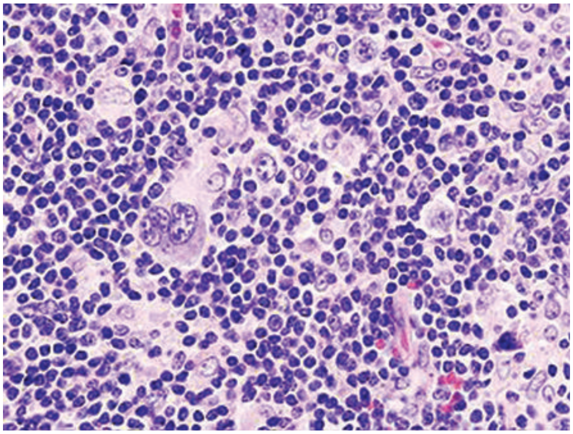

Figure 8.27 Lymph node biopsy showing Reed–Sternberg cells in Hodgkin's disease.

Combined Therapy

It is the treatment of choice.

Chemotherapeutic agents in combination like adriamycin, bleomycin, vinblastine and dacarbazine (ABVD) are administered. This is given in bulk disease. First chemotherapy is given, followed by radiotherapy to the original sites of bulk disease, which has been reduced in size by chemotherapy.

Prognosis

Prognosis is good in lymphocytic predominant and poor in lymphocytic depleted. Nodular sclerosing with mixed cellularity carries fair prognosis. If untreated, Hodgkin's disease is fatal. Five-year survival period in stage IA is 90% and in Stage IIA is 70% with therapy. Autologous BMT is tried in cases with relapse, provided BM is free of disease.

Viva voce

Q1. What are the causes of neutropenia (less than 3000/ul)?

- Bacterial infections – Typhoid, brucellosis, hematogenous tuberculosis
- Protozoal infections – Malaria, kala-azar
- Viral infections – Measles, viral hepatitis, influenza, HIV, infectious mononucleosis
- Vitamin deficiency – Vitamin B12, folic acid
- Side effects of drugs – Antimalarials, antithyroid, anticonvulsants, antiarrhythmics, sulfonamides, chemotherapeutic agents
- Systemic rheumatic diseases – SLE, Felty's syndrome
- Hypersplenism

Q2. What are the causes of lymphocytopenia (less than 1000/ul)?

- Viral infections (HIV, influenza, measles)
- Renal failure
- Following chemotherapy or radiotherapy
- Corticosteroid therapy, immunosuppressive therapy
- Thymic dysplasia
- Severe stressful illness, e.g. severe sepsis, acute myocardial infarction
- Bone marrow failure

Q3. What are the causes of eosinophilia?

- Bronchial asthma, allergic disorders, hay fever
- Loeffler's syndrome
- Tropical eosinophilia
- Hematological disorders (eosinophilic leukemia, Hodgkin's disease, myeloproliferative disorders)
- Systemic rheumatic diseases (SLE, polyarteritis nodosa, rheumatoid arthritis)
- Skin diseases (eczema, psoriasis, pemphigus, urticaria).
- Parasitic infestations (ascariasis, filariasis, hookworm, strongyloidiasis)
- Endocrine disorders (hypopituitarism, Addison's disease)
- Postsplenectomy

Q4. What are the causes of thrombocytosis?

- Polycthemia vera rubra
- Chronic myeloid leukemia
- Myeloproliferative disorders
- Myelofibrosis
- Idiopathic
- Acute infections
- Hemorrhage
- Iron deficiency
- Splenectomy
- Chronic inflammatory disorders, e.g. Still's disease, inflammatory bowel disease, systemic vasculitidis

Q5. What are the causes of thrombocytopenia?

Congenital (rare)

- Wiskott–Aldrich syndrome
- Congenital aplastic anemia

Acquired

- Drugs (sulfonamides, NSAIDS), chemotherapeutic agents, radiotherapy
- Bacterial infections (typhoid)
- Viral infections (HIV, EBV, dengue)
- Parasitic infestation (malaria)
- Aplastic anemia, megaloblastic anemia, myelophthisis
- Autoimmune thrombocytopenia (AITP)
- Idiopathic thrombocytopenic purpura
- Secondary autoimmune thrombocytopenia (lymphomas, CLL, chemotherapy, radiotherapy)
- Disseminated intravascular coagulation
- Thrombotic thrombocytopenic purpura
- Hemolytic uremic syndrome

Chapter 9

Musculoskeletal system

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- A case of osteoarthritis 298
- A case of juvenile idiopathic arthritis (juvenile RA) 300
- A case of reactive arthritis 300

EXAMINATION OF MUSCULOSKELETAL SYSTEM

Introduction

It includes examination of joints, muscles and bones.

Joints

The structure of synovial joint is shown in Fig. 9.1.

Terms used to describe joint disease are

- Arthritis – Disease of synovial membrane and/or structures within the synovium (intra-articular disorders)
- Periarthritis – Involvement of joint capsule and the structures beyond (e.g. ligament, bursa, tendon)
- Extra-articular – Means nonarticular, nonperiarticular manifestation
- Arthralgia – Joint pain without clinical evidence of joint disease

Symptoms

Common joint symptoms are pain, stiffness (morning, inactivity), swelling, limitation of joint movements, deformity and muscle weakness.

In addition, patients may present with extra-articular symptoms. These may be nonorgan specific, such as fatigue, loss of appetite, loss of weight, fever or organ specific (e.g. nephritis, pleurisy, myocarditis).

Pain

Pain is the most important manifestation of joint disease. Pain may be present at rest, on activity or

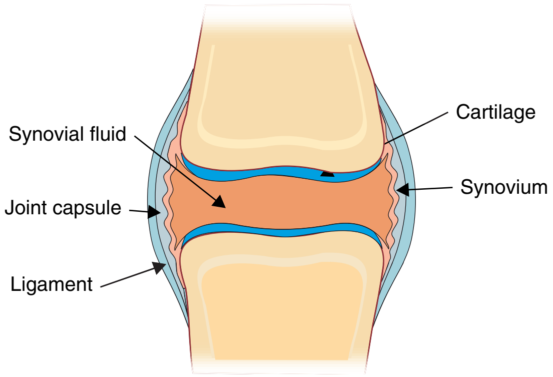


Figure 9.1 Schematic structure of synovial joint.

with both. There may be relieving and aggravating factors. Pain worsened by activity is typical of noninflammatory joint disorders. In inflammatory disorders, pain is relieved with activity. Rest has an opposite effect on both.

Pain may be referred to a joint from another joint (Table 9.1) or from a nonarticular structure, e.g. diaphragmatic, cardiac and gall bladder pain to shoulder.

Table 9.1 Patterns of radiation of pain from joints

Joint	Radiation
Cervical spine	Occiput, vertex of head, shoulder, upper extremity
Thoracic spine	Chest (girdle pain)
Lumbar spine	Buttock, hip, knee, leg
Shoulder	Deltoid tubercle
Elbow	Forearm
Hip	Thigh (anterior aspect), knee
Knee	Thigh, lateral aspect of leg

Stiffness

Stiffness is difficulty in movements of joint, that is not explained by pain. Mild, short-duration stiffness after sleep or inactivity is normal. It lasts for a few minutes only. In inflammatory diseases, stiffness lasts for an hour or longer. Patients with osteoarthritis (OA) complain of inactivity stiffness but of a shorter duration (less than 15–20 minutes). The duration of stiffness is generally proportional to the severity of inflammation.

Swelling

Swelling indicates arthritis. It may be synovial (synovial hypertrophy and/or effusion), bony or both.

Deformity

Most joint diseases lead to deformity due to damage, ligamentous laxity, malalignment of tendons and soft tissue contractures. Deformities are reversible if they are due to laxity of soft issues but irreversible if they are due to joint damage or soft tissue contracture.

Muscle weakness

Joint pain results in reflex muscle wasting and weakness, e.g. quadriceps weakness and wasting with knee arthritis. It may result in joint instability (e.g. buckling due to quadriceps weakness) and further aggravate joint damage.

Fatigue

Fatigue is an important manifestation of inflammatory disorders. Its duration and severity reflect disease activity.

History

This is the most important aspect of approach to joint disorders. Approximately 80–90% of diagnosis can be made on history alone. The details to be noted are as follows:

- Duration – Arthritis of short duration is often viral in etiology.
- Onset – Acute onset is seen with trauma, bacterial or viral infections, reactive arthritis (ReA), hemarthrosis and gout. Chronic arthritis may sometimes have an acute onset. Enquire about joints involved because there is typical pattern of joint involvement in rheumatoid arthritis, rheumatoid arthritis, spondyloarthropathies, OA and acute gout.
- Progression – Chronic inflammatory and degenerative arthritis are typically insidious in onset with progressive worsening. Fleeting arthritis is typical of rheumatic fever.
- Intermittent episodic arthritis – It is a feature of acute gout and palindromic arthritis.
- Effect of rest, activity, weather, stress, etc. should be recorded.

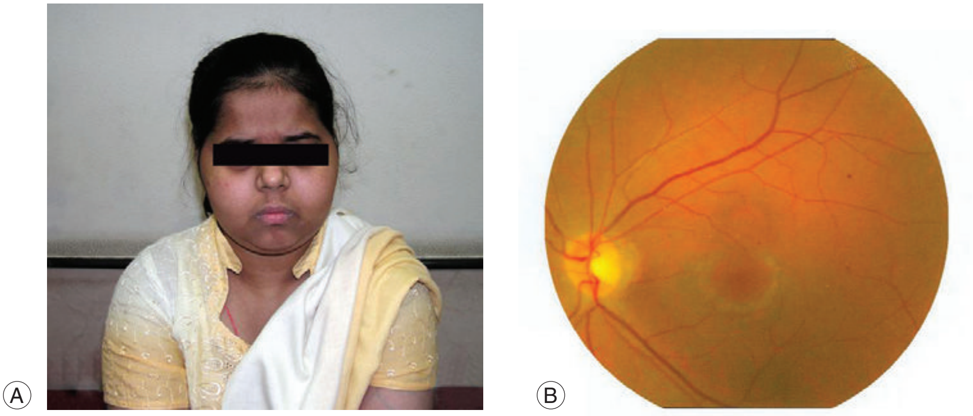


Figure 9.2 (A) Cushingoid face – Corticosteroid induced. (B) Chloroquine maculopathy.

- Extra-articular manifestations involving skin, mucus membranes and various organs.
- History of preceding and associated illnesses, e.g. sore throat before rheumatic fever, dysentery or urethritis before reactive arthritis. Arthritis may be a manifestation of inflammatory bowel disease, psoriasis, sickle-cell disease, etc.
- Medication history is important. Treatment received and response can be of diagnostic and of therapeutic significance, e.g. inflammatory back pain responds dramatically to nonsteroidal anti-inflammatory drugs (NSAIDs) but not to analgesics. Figures 9.2A and B show examples of the side effects and complications of treatment (e.g. steroids, chloroquine). Medications can precipitate rheumatic disorders e.g. sulfa (systemic lupus erythematosus [SLE]), diuretics (gout), steroids (osteoporosis, avascular necrosis of bone) and statins (myalgia).
- Family history – Gout, ankylosing spondylitis (AS) and primary generalized OA are familial disorders.
- Enquire about the ability to carry out routine activities, such as walking, climbing stairs, squatting, dressing, bathing and using Indian toilet.
- Note the socioeconomic impact.

Physical examination

General examination

A quick but complete general examination is essential. Table 9.2 lists some typical findings on general examination.

Table 9.2 Typical (almost diagnostic) findings of some rheumatic diseases

Osteoarthritis	Heberden's and Bouchard's nodes (Fig. 9.3)
Systemic lupus erythematosus	Butterfly, photosensitive facial rash
Dactylitis	Psoriatic arthritis, reactive arthritis (Fig. 9.4)
Dermatomyositis	Gottron's papules, (Fig. 9.5) heliotrope periorbital rash (Fig. 9.6)
Antiphospholipid syndrome	Livedo reticularis (also seen in polyarteritis nodosa)
Relapsing polychondritis	Chondritis, saddle nose
Wegener's granulomatosis	Saddle nose (Fig. 9.7)
Giant cell arteritis	Tender, nodular temporal arteries (Fig. 9.8)
Behcet's disease	Pathergy, hypopyon
Psoriasis	Nail pitting, onycholysis (Figs. 9.9 and 9.10)
Reactive arthritis	Keratoderma blennorrhagicum (Figs. 9.11A and B)

Examination of joints

1. **Peripheral joints** – Note the following features:
    a. Swelling – Check whether swelling is synovial (felt as soft boggy swelling with or without fluctuation) or bony. Soft swelling is due to synovitis, and bony swelling is due to osteophytes and bony hypertrophy.

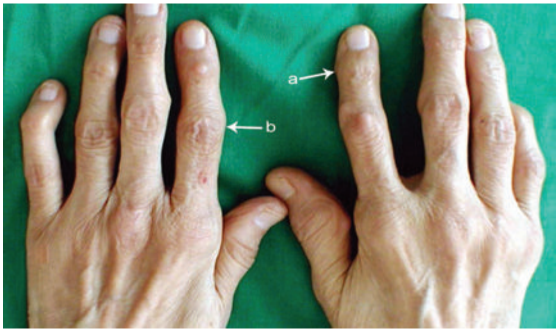


Figure 9.3 (a) Heberden's nodes. (b) Bouchard's nodes.

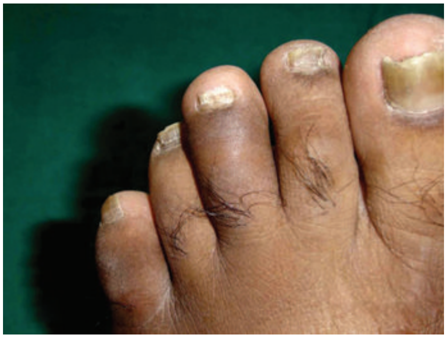


Figure 9.4 Dactylitis of third toe (sausage toe).

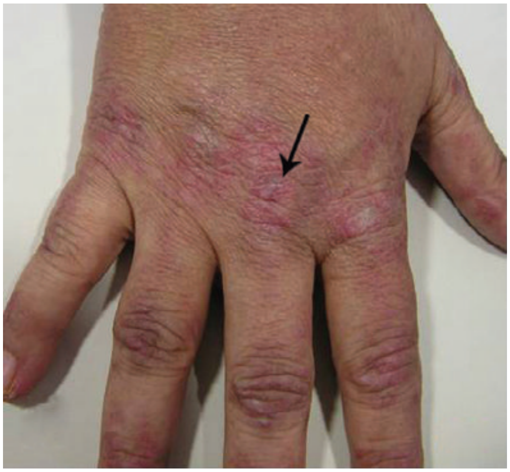


Figure 9.5 Gottron's rash over knuckles of hand.

b. Tenderness – Diffuse joint tenderness is present in inflammatory arthritis. Localized tenderness suggests soft tissue problem of ligament, bursa or tendon. Localised tenderness is present in OA also. Tenderness is tested by applying gentle pressure and noting patient's response as

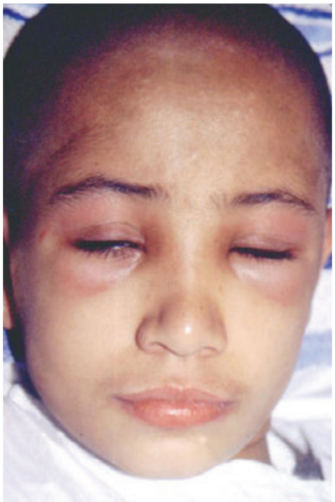


Figure 9.6 Heliotrope rash over eyelids.

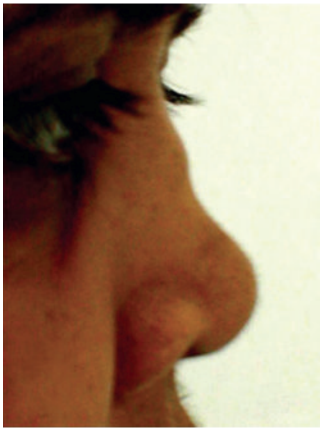


Figure 9.7 Saddle nose deformity.

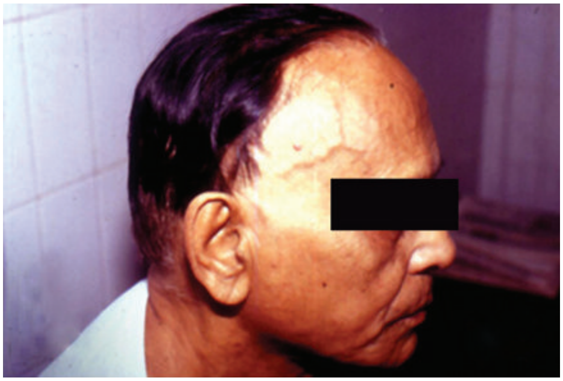


Figure 9.8 Tortuous and dilated superficial temporal artery.

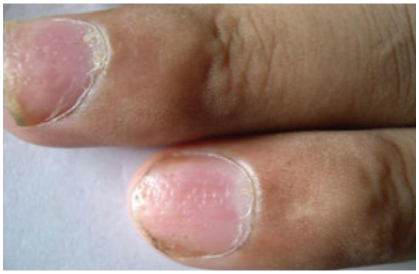


Figure 9.9 Nail pitting.

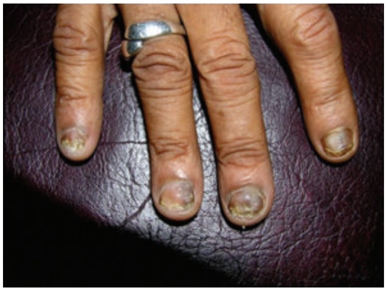


Figure 9.10 Onycholysis.

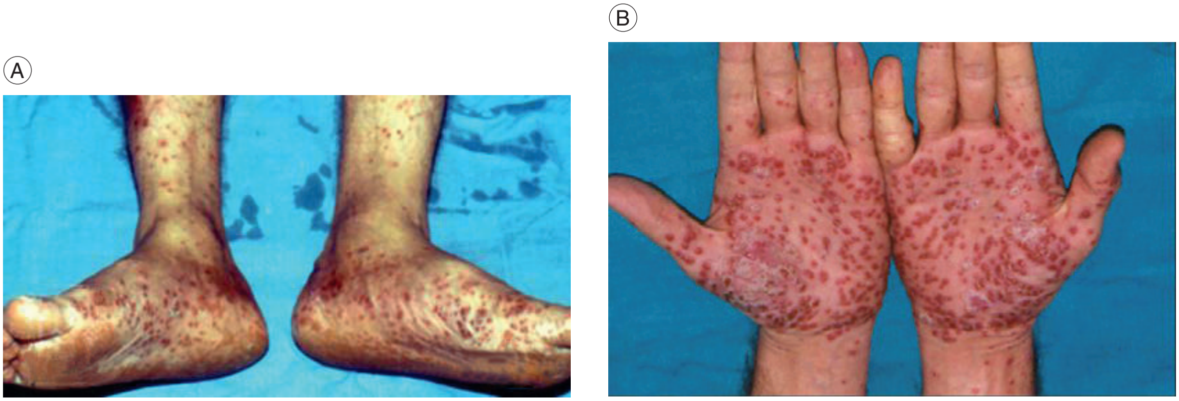


Figure 9.11 (A) Keratoderma blennorrhagica (feet). (B) Keratoderma blennorrhagica (hands).

mild (tells), moderate (winces) or severe (withdraws).

- **c.** Warmth – Local warmth indicates inflammation. In acute pyogenic arthritis and acute gouty arthritis, joint is significantly warm or even hot.
- **d.** Movements – Both active and passive movements of joints are tested for pain and range of movement. In arthritis, active and passive movements are equally restricted, while with periarticular disorders, the range of passive movements is more than that of active movements.
- **e.** Crepitus – It is a crackling, grating sensation felt or heard during joint movement. Soft crepitus is due to synovitis, while coarse crepitus is due to (severe) cartilage damage or bone erosion. Snapping or cracking sound (due to slipping of tendons or ligaments) has no pathological significance.
- **f.** Joint instability – It can result from loss of bone and cartilage, laxity of joint capsule or ligaments and muscle weakness. It results in abnormal joint movement(s).
- **g.** Joint deformity – It may be reversible or irreversible. Fixed deformity is due to ankylosis or contracture of soft tissues.
- **h.** Atrophy – Atrophy and weakness of muscles adjoining the affected joint.

Spine

1. Inspection – Check for the alignment of spine. Abnormalities of alignment are kyphosis, scoliosis, kyphoscoliosis, gibbus, excessive lumbar lordosis, loss of lumbar lordosis and torticollis (see Figs. 1.45 and 1.46; see Chapter 1 pg. 27 for details).
2. Palpation – Check for localized or diffuse tenderness and spasm of paraspinal muscles.
3. Movements – Determine the range of movements and pain during movements of cervical, thoracic and lumbar spines.
4. Additional examination
    - **a.** Neurologic examination is done if symptoms are suggestive of myelopathy, radiculopathy and bladder or bowel dysfunction.
    - **b.** Examination of abdomen is done in patients with low back pain (for aortic aneurysm, other retroperitoneal pathologies and pelvic or urinary tract disorders).

Extra-articular manifestations

These may involve skin, mucous membranes, eyes, hands, external genitalia, lymph nodes, salivary glands and internal organs. Rheumatic diseases associated with nodules, skin rash, Raynaud's phenomenon, orogenital ulcers and eye involvement are mentioned in Boxes 9.1–9.5.

Rheumatic diseases with subcutaneous nodules

Box 9.1

- Rheumatoid arthritis (Fig. 9.12)
- Gout (Fig. 9.13)
- Rheumatic fever
- Systemic lupus erythematosus
- Erythema nodosum (Fig. 9.14A and B)
- Methotrexate induced
- Hypercholesterolemia (xanthomas)
- Multicentric reticulohistiocytosis

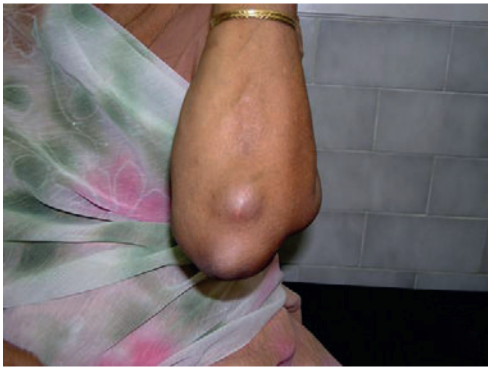


Figure 9.12 Subcutaneous nodule.

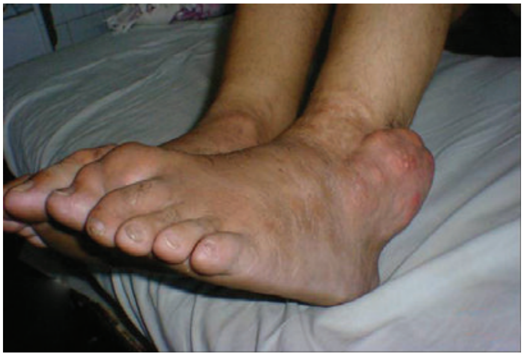


Figure 9.13 Tophi feet.

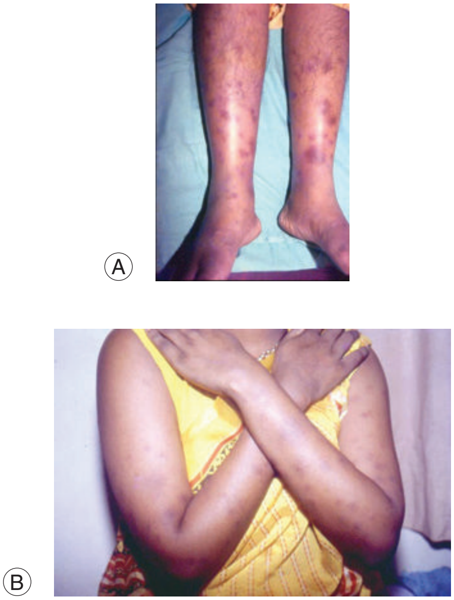


Figure 9.14 (A) Erythema nodosum (legs). (B) Erythema nodosum (forearms).

Rheumatic diseases with skin rash

Box 9.2

- Psoriasis (Fig. 9.15)
- Systemic lupus erythematosus (Fig. 9.16)
- Dermatomyositis
- Reactive arthritis
- Rheumatic fever
- Still's disease
- Cryoglobulinemia
- Drug reaction
- Sarcoidosis (Fig. 9.17)
- Henoch–Schönlein's purpura (Fig. 9.18)
- Viral infection (e.g. rubella, dengue)
- Others (e.g. gonococcal arthritis, Lyme disease)

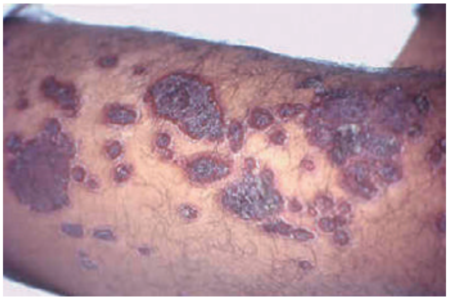


Figure 9.15 Psoriasis skin.

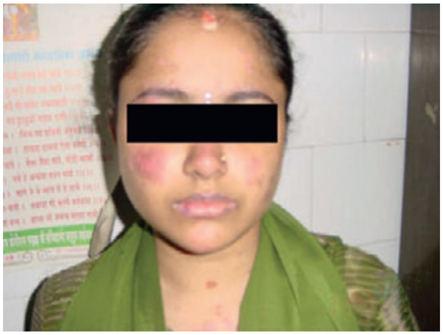


Figure 9.16 SLE butterfly rash face with sparing of nasolabial folds.

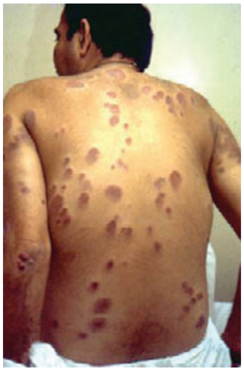


Figure 9.17 Sarcoidosis – Cutaneous lesions.

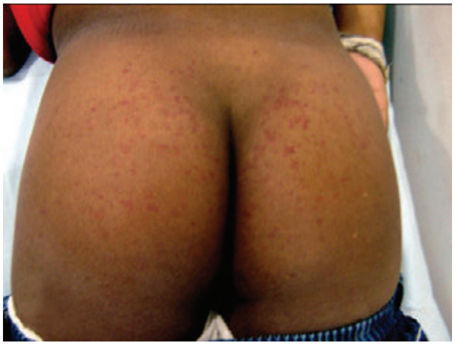


Figure 9.18 Henoch–Schönlein's purpura.

Rheumatic diseases with Raynaud's phenomenon (Fig. 9.19) — Box 9.3

- Systemic sclerosis (SSc)
- Mixed connective tissue disease
- Rheumatoid arthritis
- Sjögren's syndrome
- Systemic vasculitis
- Cryoglobulinemia

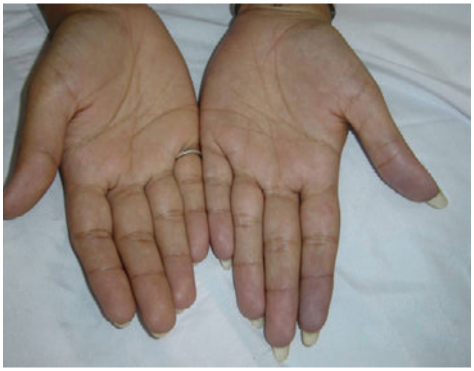


Figure 9.19 Raynaud's phenomenon.

Rheumatic diseases with genital and oral ulcers — Box 9.4

- Reiter's syndrome
- Behcet's disease (BD; Fig. 9.20)
- Crohn's disease

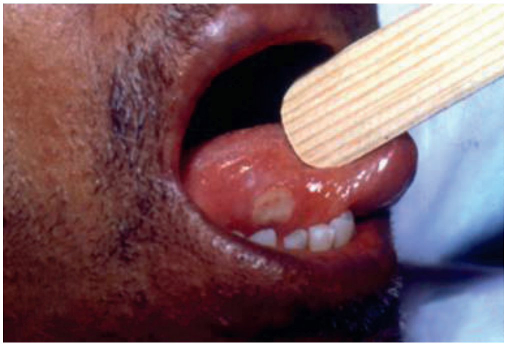


Figure 9.20 Aphthous ulcer tongue (BD).

Rheumatic diseases with eye involvement — Box 9.5

- Rheumatoid arthritis (Fig. 9.21)
- Sjögren's syndrome (Fig. 9.22)
- Spondyloarthropathies
- Juvenile idiopathic arthritis (JIA)
- Systemic lupus erythematosus
- Vasculitis
- Sarcoidosis
- Wegener's granulomatosis (WG), polyarteritis nodosa
- Behcet's disease
- Relapsing polychondritis

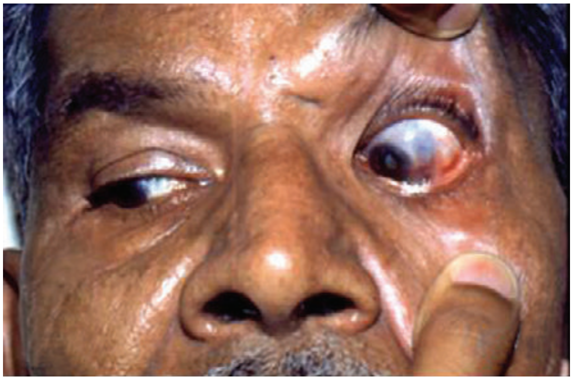


Figure 9.21 Scleritis left eye (RA).

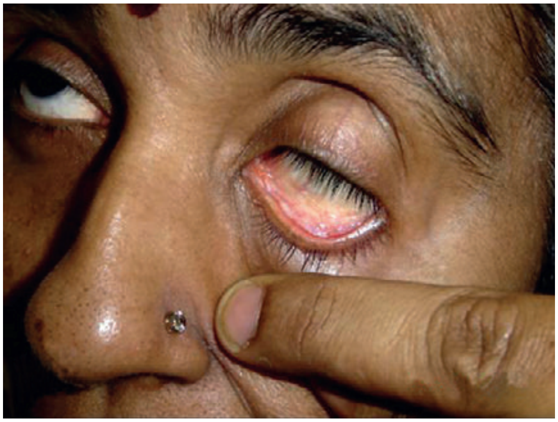


Figure 9.22 Ropy discharge eye (Sjögren's syndrome).

Systemic examination

A quick examination of cardiovascular, respiratory, gastrointestinal and nervous systems should be carried out.

Gait, arms, legs and spine (GALS)

A simple gait, arms, legs and spine (GALS) system has been evolved to quickly assess if a patient has a musculoskeletal disorder or not. This consists of the following:

1. Screening history – A patient is asked the following three questions, and if the answer to all three is negative, a significant musculoskeletal disorder can be excluded.
   - **a.** Is there pain or stiffness of joints, muscles or back?
   - **b.** Can the patient dress without any difficulty?
   - **c.** Can the patient climb up and come down the steps without any difficulty?

   If answer to one or more question is in affirmative, a screening examination is carried out.
2. Screening examination – Screening examination of GALS is as follows:
   - **a.** Gait – Observe the patient's gait while walking towards and away from you.
   - **b.** Arms
     - **i.** Ask the patient to put his hands behind his head and note shoulder and elbow movements (free, painful, or limited?), hold his arms straight in front and note extension of elbows, pronate and supinate his forearms and touch tip of his each finger with his thumb.
     - **ii.** Note deformities of fingers.
     - **iii.** Check grip strength.
     - **iv.** Gently squeeze metacarpal joints to detect pain. Also note joint swelling.
   - **c.** Legs
     - **i.** With the patient standing, note swelling, deformity and limb shortening.
     - **ii.** Ask the patient to lie on a couch or bed, flex knee and hip and feel for crepitus in knee joint. Note pain and limitation of flexion at knee and hip.
     - **iii.** Rotate the hips internally and externally and note pain and limitation of movements.
     - **iv.** Examine knees for swelling, warmth and tenderness.
     - **v.** Squeeze metatarsals gently.
     - **vi.** Examine soles of feet for ulcers and callosities.
   - **d.** Spine
     - **i.** With the patient in standing position, examine from behind and sides for abnormalities of spinal curvatures.
     - **ii.** Ask the patient to bend forward and try and touch his toes (without bending knees). Note limitation and pain.
     - **iii.** Standing in front of the patient, ask the patient to bend his neck and to touch ear to shoulder on either side. Note range of movement.
     - **iv.** Gently press midpoint of each supraspinatus muscle for tenderness.

Investigations

Complete blood count (including platelet count) and routine urine examination are performed in all cases. Liver and renal function tests are necessary for monitoring side effects of therapy (NSAIDs, Disease modifying anti rheumatic drugs [DMARDs]). More specific tests include the following:

1. Investigations for evidence of inflammation
    - **a.** Erythrocyte sedimentation rate (ESR) – It is useful for screening and monitoring disease activity. The test lacks specificity.
    - **b.** C-reactive protein (CRP) – It is a more sensitive test than ESR, but it is also a nonspecific marker of inflammation. It has rapid kinetics and therefore is often preferred over ESR. Similar to ESR, it is useful to monitor disease activity.
    - **c.** Serum complement – Serum complement levels are low in immune complex–mediated diseases and are a good marker of disease activity in SLE.
2. Specific tests – There are no tests of absolute diagnostic value.
    - **a.** Rheumatoid factor (RA test) – Detection of rheumatoid factor is not specific for RA. The test is positive in many rheumatic and nonrheumatic diseases and also in normal individuals, especially the elderly (Table 9.3).
    - **b.** Anticyclic citrullinated peptide (CCP) antibody – Anti-CCP antibodies high specificity and sensitivity for RA. The test is positive very early in RA.
    - **c.** Antinuclear antibody – Antinuclear antibody (ANA) or antinuclear factor test is useful for the diagnosis of SLE (sensitivity 95%), but it is not specific as the test is positive in other rheumatic and nonrheumatic disorders (Table 9.4).
    - **d.** Anti-dsDNA antibody – This test is specific for SLE. It should be ordered only if ANA test is positive.
    - **e.** Antibodies to extractable nuclear antigens
        - **i.** Anti-Ro, anti-La (Sjögren's syndrome, SLE)
        - **ii.** anti-nRNP (mixed connective tissue disease, SLE)
        - **iii.** anti-Sm (SLE)
    - **f.** Other antigen specific tests – These are discussed with individual diseases.
    - **g.** Antineutrophil cytoplasmic antibodies (ANCA) – These are present in the sera of patients with systemic necrotizing vasculitis. On the basis of immunofluorescence staining, two patterns are recognized.
        - **i.** Cytoplasmic or C-ANCA pattern – It is specific for proteinase 3 (PR3) and is present in WG.
        - **ii.** Perinuclear or P-ANCA pattern – It has specificity for myeloperoxidase and is seen in microscopic polyangiitis and Churg–Strauss syndrome.

Table 9.3 Disease associations of rheumatoid factor

Systemic rheumatic diseases

- Rheumatoid arthritis
- Sjögren's syndrome
- Systemic lupus erythematosus
- Mixed connective tissue disease
- Scleroderma

Infections

- Viral (e.g. HIV, EBV, HBV, HCV)
- Bacterial (e.g. tuberculosis, leprosy, infective endocarditis)
- Parasitic (e.g. kala-azar, malaria)
- Vaccination

Lymphoproliferative malignancies

Others

- Hypergammaglobulinemic purpura
- Cryoglobulinemia
- Chronic liver disease
- Sarcoidosis
- Interstitial lung disease

Table 9.4 Disease associations of ANA

Autoimmune rheumatic diseases

- SLE, drug-induced lupus, Sjögren's syndrome, systemic sclerosis, polymyositis-dermatomyositis, JIA, RA

Other autoimmune diseases

- Autoimmune chronic active hepatitis, primary autoimmune cholangitis, autoimmune thyroid disease, myasthenia gravis

Nonautoimmune diseases

- Leprosy, infective endocarditis, infectious mononucleosis, Waldenström's macroglobulinemia

h. Antiphospholipid antibodies – Three tests are available.

  i. IgG, IgM, anticardiolipin (aCl) antibodies – These antibodies are present in high titer in sera of patients with primary and secondary antiphospholipid syndrome.

  ii. Tests for the presence of lupus anticoagulant are useful, especially when aCl antibodies are not detected.

  iii. Antibodies to β2GP1 are tested when more than two tests are negative, but the diagnosis of antiphospholipid syndrome is clinically strongly suspected.

The three tests are not mutually exclusive.

i. Antistreptolysin O antibodies – Presence of antistreptolysin O antibodies suggests recent streptococcal infection. Titers greater than 1:200 are taken as significant.

j. Human leucocyte antigen – In ankylosing spondylitis (AS), though there is a strong association with human leucocyte antigen HLA-B27 (95% cases), it is not diagnostic of AS as HLA-B27 is present in healthy individuals also. Similarly, HLA DR1 and DR4 are significantly but not exclusively and invariably associated with RA. HLA testing is neither required nor advised in routine clinical practice.

k. Serum uric acid – Elevated serum uric acid is a feature of gout. However, raised levels can be seen in other situations and in healthy individuals. Hyperuricemia by itself is not diagnostic of gout (Box 9.6).

Some important causes of hyperuricemia **Box 9.6**

- Idiopathic
- Inborn errors of purine metabolism
- Excessive purine intake
- Dehydration
- Anoxia
- Alcohol
- Drugs (pyrazinamide, ethambutol, cyclosporine, diuretics)
- Ketoacidosis, lactic acidosis
- Excessive nucleotide turnover (hematologic malignancies, psoriasis), hemolytic anemia
- Lead nephropathy

l. Examination of synovial fluid – Monoarthritis is the most important indication for examination of synovial fluid. The synovial fluid findings in selected arthritidis are shown in Table 9.5.

m. Chest x-ray, pulmonary function tests 2D echo etc are done as required.

Table 9.5 Synovial fluid characteristics of selected arthritidis

Rheumatoid arthritis

- Cloudy, with decreased viscosity
- Poor mucin clot
- Cells 5000–30,000/mm^3
- Polymorphs 50–80%
- Proteins 2.5 g–3.5 g/dl
- Sugar 25–50% less than corresponding blood sugar level

Pyogenic arthritis

- Yellow, purulent fluid
- Low viscosity
- Poor mucin clot formation
- Cells 50,000–1,00,000/mm^3
- Polymorphs > 75% (up to 100%)
- Proteins 3.0 g–4.0 g/dl
- Sugar > 50% of the corresponding blood sugar level

Gout

- Translucent or cloudy
- Low viscosity
- Cells 200 to >50,000/mm^3
- Polymorphs > 90%
- Urate crystals+

Pseudogout

- Same as gout except crystals are of calcium pyro phosphate dihydrate

Tuberculosis

- Resembles RA except for lymphocyte predominance

Reactive arthritis, psoriatic arthritis

- Translucent, low viscosity
- Cells 2000–50,000/mm^3
- Polymorph predominant

Muscles

Symptoms

The common symptoms of muscle disease are
- Muscle weakness (Box 9.7)
- Muscle tenderness
- Muscle wasting
- Cramps

Physical examination

1. Note
   a. Muscle atrophy (primary muscle disease, neurogenic, disuse, reflex muscle wasting)
   b. Muscle hypertrophy, e.g. Duchenne's muscular dystrophy
   c. Muscle strength (see Chapter 5 pg. 174)
   d. Tenderness (inflammation)
   e. Myotonia, e.g. myotonic dystrophy (Fig. 9.25)
   f. Contracture
   g. Deep tendon reflexes (see Chapter 5 pg. 178)
   h. Pattern and distribution of muscle involvement
      i. Proximal muscle weakness is seen with myopathies (inflammatory, metabolic, drug induced, endocrine)
      ii. Muscular dystrophies have characteristic distribution of muscle weakness, wasting and hypertrophy

   Primary muscle disorders do not involve external ocular muscles. There are no fasciculations or sensory loss. Deep tendon reflexes are preserved till late.
2. General examination and review of cardiovascular, respiratory and gastrointestinal systems
3. Investigations

Causes of muscle weakness **Box 9.7**

- Inflammation (polymyositis, dermatomyositis; Fig. 9.23)
- Muscular dystrophy (Fig. 9.24)
- Infection (viral, bacterial, parasitic)
- Metabolic (vitamin D deficiency, electrolyte disturbances)
- Endocrine (hypo and hyperthyroidism, Cushing's syndrome)
- Drugs (steroids, statins)
- Ischemia
- Neuromuscular junction diseases (myasthenia gravis, Eaton–Lambert syndrome, drugs)
- Secondary to joint disease

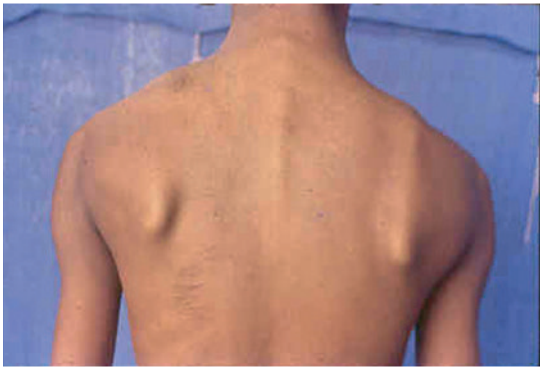


Figure 9.24 Muscle wasting, winging of scapula (facioscapulohumeral muscular dystrophy).

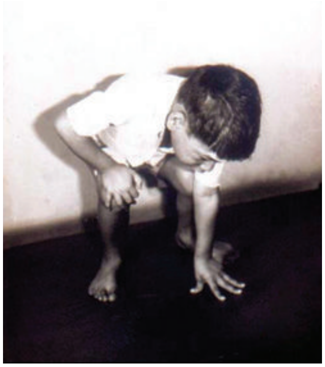


Figure 9.23 Gower's sign (pelvic girdle muscle weakness).

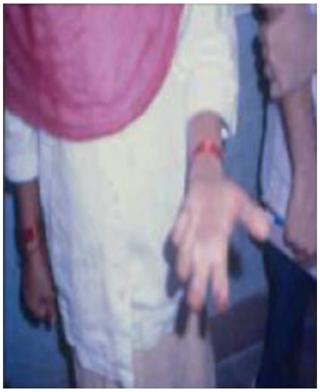


Figure 9.25 Myotonia (slow relaxation of grip).

- **a.** Muscle related
  - **i.** Muscle enzymes, such as CPK, LDH, SGOT, SGPT, and aldolase are elevated with muscle injury of any cause. Serial estimation is useful to monitor response to treatment
  - **ii.** EMG and nerve conduction studies for the diagnosis of myopathy and differentiation from neurogenic cause
  - **iii.** Muscle biopsy for routine histopathology and special studies
  - **iv.** Magnetic resonance imaging (MRI) to detect active inflammation, atrophy, and fibrosis (Fig. 9.26)
  - **v.** Muscle specific antibodies (e.g. anti-JO-1, anti-SRP) – Useful to identify subsets of dermatomyositis
- **b.** Others
  - **i.** Antinuclear antibodies and their specificities
  - **ii.** Chest X-ray, pulmonary function tests, 2D echo and barium swallow as indicated

Bones

Symptoms of bone disease are as follows:

- Bone pain
- Deformity

Boxes 9.8 and 9.9 list causes of diffuse bone pain and bone deformity, respectively.

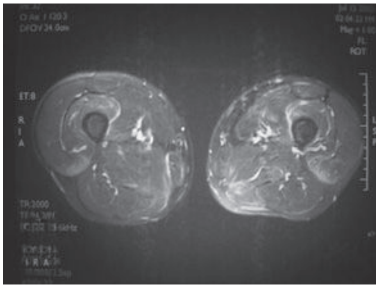


Figure 9.26 MRI thigh - muscle inflammation (white).

Causes of diffuse bone pain (Fig. 9.27A and B) **Box 9.8**

- Osteomalacia, rickets
- Osteoporosis (Osteoporosis by itself is painless. Pain is due to fractures.)
- Widespread secondaries
- Leukemia, myeloma

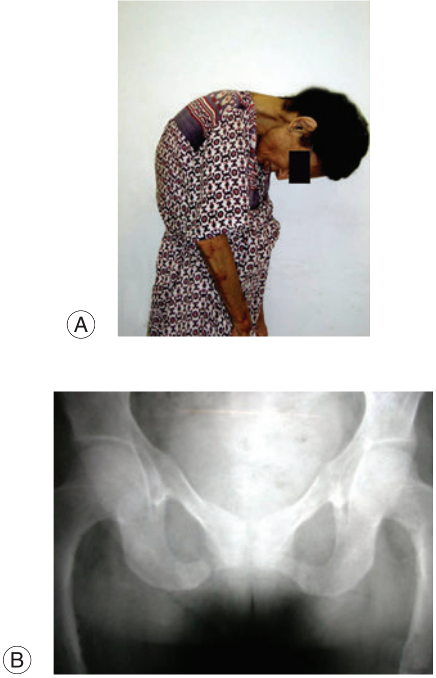


Figure 9.27 (A) Extreme kyphosis (osteoporosis). (B) Osteomalacia, pelvis X-ray (bilateral pseudofractures of pelvic rami).

Causes of bone deformities **Box 9.9**

- Rickets
- Malunited fracture(s)
- Osteoporosis
- Osteogenesis imperfecta
- Developmental and inherited disorders of bone
- Growth abnormalities

Investigations

- Serum calcium, phosphorous, alkaline phosphatase, acid phosphatase and serum albumin (for metabolic bone disease)
- Serum vitamin D and parathyroid hormone (osteomalacia, parathyroid disorders)
- X-ray, scans (computed tomography [CT], magnetic resonance imaging, radionuclide double energy x-ray absorptiometry [DEXA])
- Bone biopsy
- Specific investigations for systemic diseases (e.g. renal, parathyroid, osteoporosis etc)

CLINICAL CASES

A case of rheumatoid arthritis

Rheumatoid arthritis is a chronic systemic autoimmune disease with arthritis as its main manifestation. If untreated, it leads to progressive joint destruction, deformity, disability and shortened life span. It affects 0.5–0.75% of Indian adults.

1. **Clinical features**
    - **a.** Articular manifestations – Pain, swelling, stiffness, limitation of joint movements, tenderness and progressive deformities (Figs. 9.28–9.34). Characteristic hand deformities are listed in Box 9.10.
    - **b.** Juxta-articular manifestations
        - **i.** Tenosynovitis, trigger finger
        - **ii.** Bursitis (Fig. 9.35)
    - **c.** Extra-articular manifestations (Fig. 9.36)

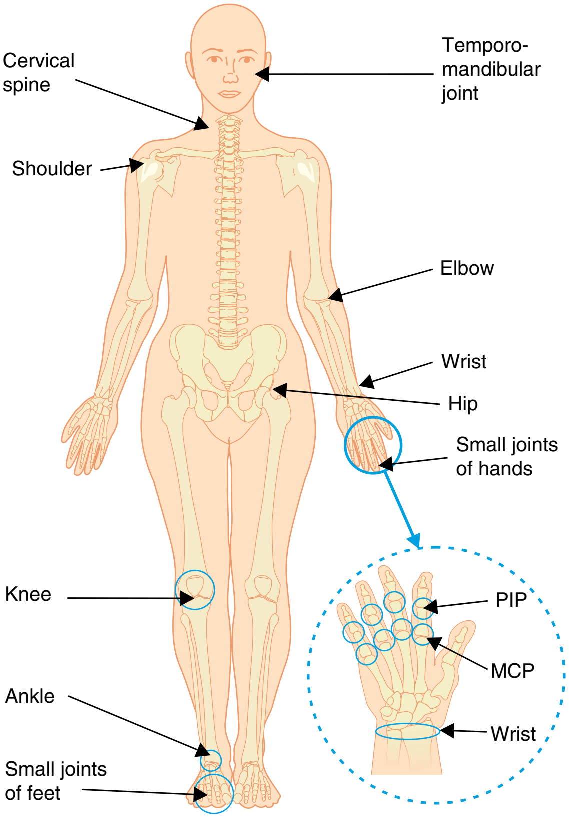

Cervical spine
Temporo-mandibular joint
Shoulder
Elbow
Wrist
Hip
Small joints of hands
Knee
Ankle
Small joints of feet
PIP
MCP
Wrist

Figure 9.28 Joints commonly involved in RA.

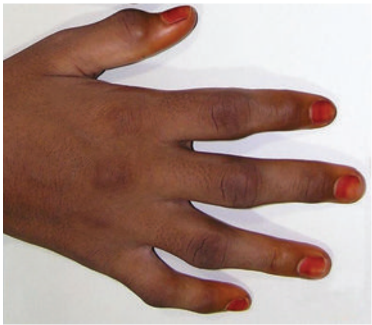


Figure 9.29 Early RA – Fusiform swelling of proximal interphalangeal (PIP) joints.

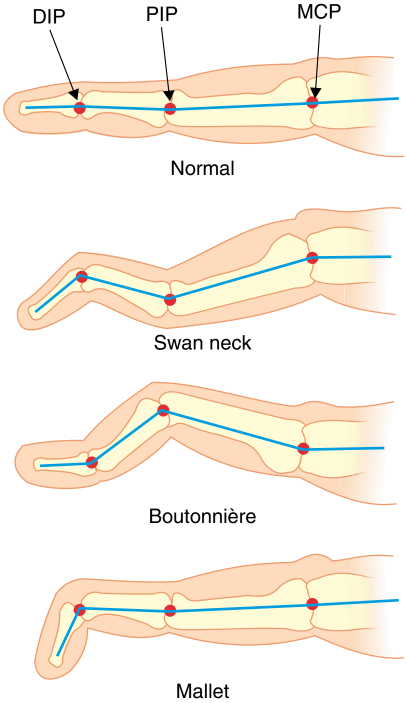

DIP
PIP
MCP
Normal
Swan neck
Boutonnière
Mallet

Figure 9.30 Finger deformities in RA.

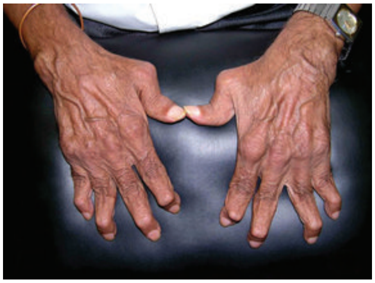


Figure 9.31 Swan neck deformity of fingers.

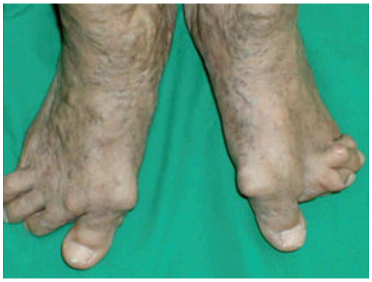


Figure 9.32 Valgus and hammer toe deformities.

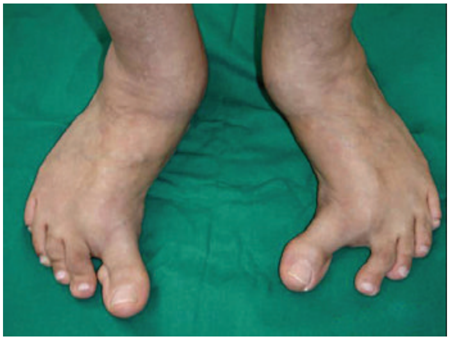


Figure 9.33 Varus deformity of toes.

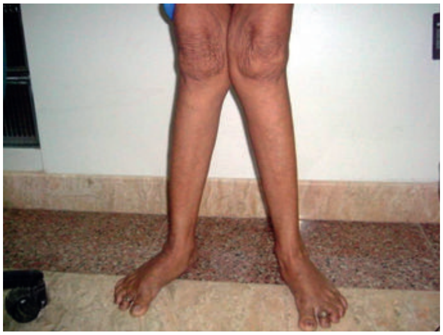


Figure 9.34 Valgus deformity of knees.

Characteristic deformities of hand and wrist in RA — Box 9.10

- Swan neck and boutonniere deformities of fingers
- Ulnar deviation and volar subluxation at metacarpophalangeal (MCP) joints
- Dropped fingers
- Radial deviation at wrist
- Dinner-fork deformity
- Dorsal subluxation of lower end of ulna (piano sign)

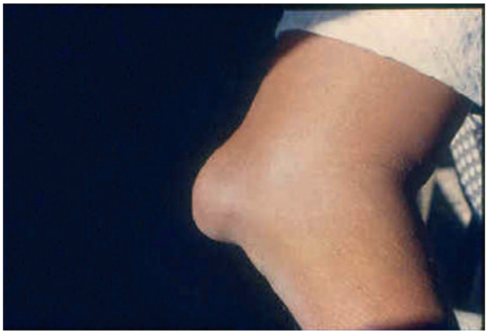


Figure 9.35 Olecranon bursitis.

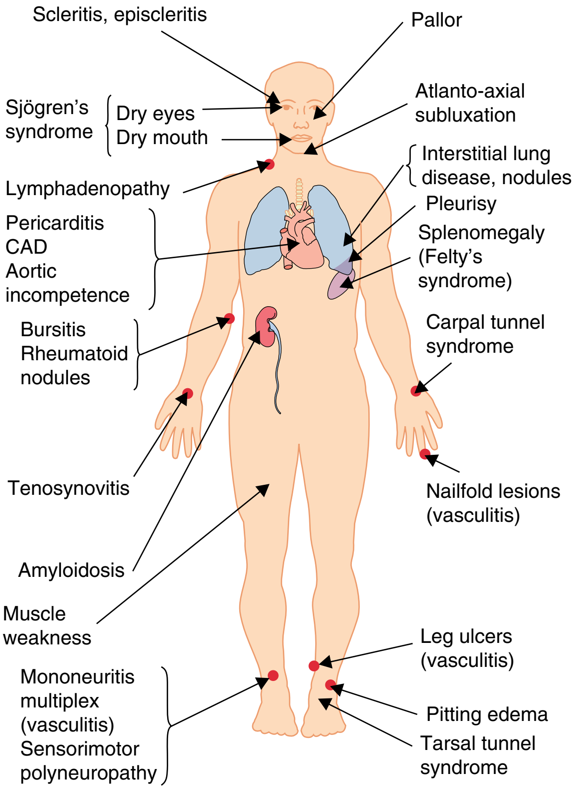

Scleritis, episcleritis
Pallor
Sjögren's syndrome
Dry eyes
Dry mouth
Atlanto-axial subluxation
Interstitial lung disease, nodules
Lymphadenopathy
Pleurisy
Pericarditis
CAD
Aortic incompetence
Splenomegaly (Felty's syndrome)
Bursitis
Rheumatoid nodules
Carpal tunnel syndrome
Tenosynovitis
Nailfold lesions (vasculitis)
Amyloidosis
Muscle weakness
Leg ulcers (vasculitis)
Mononeuritis multiplex (vasculitis)
Sensorimotor polyneuropathy
Pitting edema
Tarsal tunnel syndrome

Figure 9.36 Extra-articular manifestations of RA.

2. **Laboratory findings**
   a. Anemia
   b. Raised ESR and CRP
   c. Rheumatoid factor and anti-CCP antibodies positive in majority
3. **X-ray changes (Fig. 9.37)** – Soft tissue swelling, juxta-articular osteoporosis, uniform joint space narrowing, juxta-articular (marginal) erosions, deformities, bone cysts, ankylosis, pencil-in-cup deformity (uncommon).

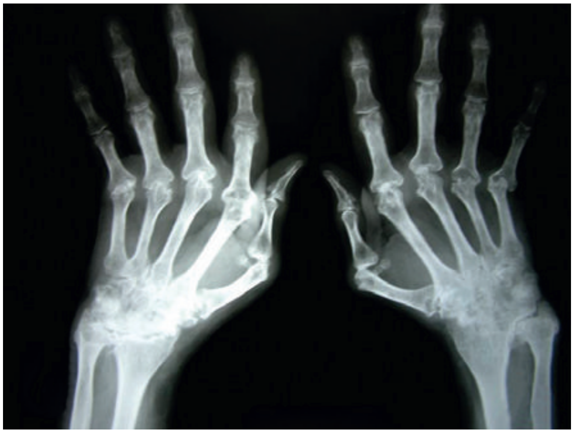


Figure 9.37 Ankylosis of wrists with radial deviation, osseous erosions, loss of joint space, subluxation and ulnar deviation at MCP joints. The distal interphalangeals (DIPs) show incidental osteoarthritic changes.

4. **Complications** – Systemic vasculitis, osteoporosis, tendon rupture, cord compression (secondary to atlantoaxial or subaxial subluxation), accelerated atherosclerosis, secondary amyloidosis, ruptured Baker's cyst, carpal tunnel syndrome and infection
5. **Differential diagnosis of RA (Table 9.6)**
    - a. Psoriatic arthritis
    - b. Reactive arthritis
    - c. Osteoarthritis
    - d. Spondyloarthropathy
    - e. Juvenile idiopathic arthritis
    - f. Systemic lupus erythematosus and other systemic connective tissue diseases, including vasculitis
    - g. Chronic tophaceous gout and other crystal arthropathies
    - h. Chronic infection (tuberculosis usually causes monoarthritis)
    - i. Infective endocarditis
    - j. Inflammatory bowel disease-related arthritis
    - k. Malignancy associated arthritis (leukemia, hypertrophic osteoarthropathy)
    - l. Sarcoidosis, sickle-cell disease, serum sickness, Behcet's disease
    - m. Viral (rubella, dengue)
6. **Management**
    - a. Pain relief with analgesics, NSAIDs
    - b. Control disease with methotrexate, leflunomide, sulfasalazine, chloroquine, hydroxychloroquine, singly or in combinations
        - i. Methotrexate 10–25 mg once a week oral or subcutaneous
        - ii. Leflunomide 10–20 mg OD
        - iii. Sulfasalazine 2–3 g/day in divided doses
        - iv. Hydroxychloroquine – 400 mg/day for 2 months, then 200 mg/day
        - v. Chloroquine – 300 mg/day (base) for 2 months, then 150 mg/day (base)
        - vi. Glucocorticosteroids
            - Oral – Prednisolone 5–10 mg OD

Table 9.6 **Typical patterns of joint involvement in common oligoarticular and polyarticular* arthritis**

Rheumatoid arthritis	Psoriatic arthritis	Spondyloarthropathies (SpA)	Primary generalized OA
• Polyarticular	• Poly or oligoarticular	• Oligoarticular	• Polyarticular
• Affects both large and small joints of UL and LL	• Affects large and small joints	• Affect large and small joints	• Affects large and small joints
• Involves joints symmetrically	• Asymmetric joint involvement	• Asymmetric joint involvement	• Symmetric joint involvement
• Does not involve DIP joints	• Involves DIP joints	• LL joints involved > UL joints	• DIP joints typically involved
• Upper limb joints involved ≥ lower limb joints	• Dactylitis, opera glass deformity characteristic	• Involve sacroiliac (SI) joints	• LL joints involved > UL joints
• Involves cervical spine	• SI joints and spine involved in SpA variety	• Enthesitis +	• 1st CMC, 1st MTP joints commonly involved
• Lumbar spine or SI joints not involved			• Lumbar spine often affected

Oligo-2–4 joints, Polyarticular-five or more joints, SpA-spondyloarthropathy, DIP-distal interphalangeal, LL-lower limb, UL-upper limb, CMC-carpometacarpal, MTP-metatarsophalngeal

  - Intramuscular – Prednisolone 80–120 mg once a month for 3–6 months (maximum)
  - Intra-articular
- **c.** Biologics (TNF-α antagonists and other biologics)
- **d.** Others, e.g. cyclosporine, azathioprine
- **e.** Maintenance of joint function and prevention of deformities – Physiotherapy, splints
- **f.** Surgery – For carpal tunnel syndrome, atlantoaxial (AA) subluxation, synovectomy; joint replacement
- **g.** Nutrition (including calcium and vitamin D)

A case of ankylosing spondylitis

It is a chronic systemic disorder with predilection to involve axial skeleton (in addition to peripheral joints), enthesis and a strong association with HLA-B27. It is more common in men. Bilateral sacroiliitis is the hallmark of the disease.

1. Clinical features

- **a.** Musculoskeletal manifestations
  - **i.** Low back and buttock pain (often alternating)
  - **ii.** Significant early morning stiffness and inactivity stiffness
  - **iii.** Bilateral sacroiliitis
  - **iv.** Progressive involvement of lumbar, thoracic and cervical spine with painful limitation of movements
  - **v.** Paravertebral muscle spasm
  - **vi.** With advanced disease, spinal deformities, (kyphosis, scoliosis), stooped posture (Fig. 9.38)
  - **vii.** Limitation of chest expansion
  - **viii.** Predominantly lower limb, asymmetric, large joint oligoarthritis
  - **ix.** Enthesitis (heel, tibial tubercle, chest)
- **b.** Extra-articular manifestations
  - **i.** Constitutional features
  - **ii.** Recurrent, unilateral acute anterior uveitis, conjunctivitis
  - **iii.** Apical pulmonary fibrosis with cavities mimicking pulmonary tuberculosis

2. Complications – Osteoporosis, atlanto-axial subluxation (may cause cord compression), vertebral fracture, secondary amyloidosis and IgA nephropathy

3. X-ray findings

- **a.** Sacroiliac joints (symmetrical involvement)
  - **i.** Grade I – Periarticular osteopenia and mild blurring of SI joint margins
  - **ii.** Grade II – Erosions with pseudowidening of joint space and subchondral sclerosis
  - **iii.** Grade III – Patchy joint space narrowing (ankylosis) (Fig. 9.39)
  - **iv.** Grade IV – Total ankylosis
- **b.** Spine (Fig. 9.40)
  - Osteitis
  - Squashing of vertebral bodies
  - Bilateral symmetrical bridging syndesmophytes (Bamboo spine)
  - Intervertebral disc calcification
  - Fusion of apophyseal joint
  - Large ossifications bridging several vertebrae
  - Calcification of anterior longitudinal interspinous and supraspinous ligaments
  - Osteoporosis.

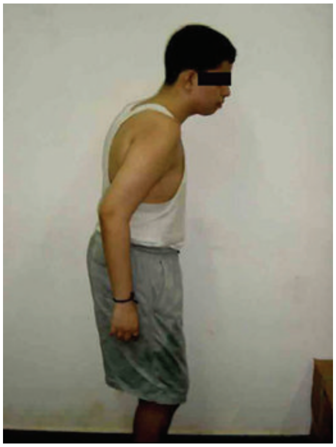


Figure 9.38 Ankylosing spondylitis (stooped posture).

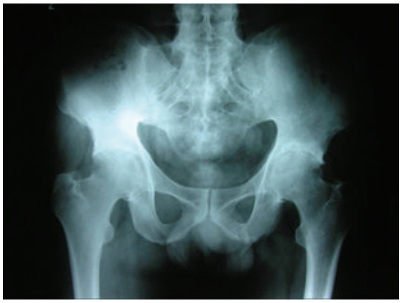


Figure 9.39 Bilateral sacroiliitis and hip arthritis

4. **Other investigations**
    - a. Computed tomography, MRI and nuclear scan are more sensitive imaging techniques. Magnetic resonance imaging most sensitive and hence useful for early diagnosis.
    - b. HLA-B27 – Not advised for routine clinical use.
    - c. Others as indicated
5. **Differential diagnosis** – It is from RA (Table 9.7), other spondyloarthropathies and diffuse idiopathic hypertrophic skeletal hyperostosis (DISH).
6. **Management (principles)**
    - a. Exercises – Physiotherapy, swimming, deep breathing
    - b. Nonsteroidal anti-inflammatory drugs – Mainly used for symptomatic relief
    - c. Sulfasalazine – May help peripheral arthritis
    - d. Axial disease – TNF-α blockers, pamidronate
    - e. Methotrexate, chloroquine and hydroxychloroquine – Not effective
    - f. Steroids – Systemic steroids not recommended for articular manifestations
        - i. Intra articular steroid as necessary
        - ii. Local eye drops for iridocyclitis.

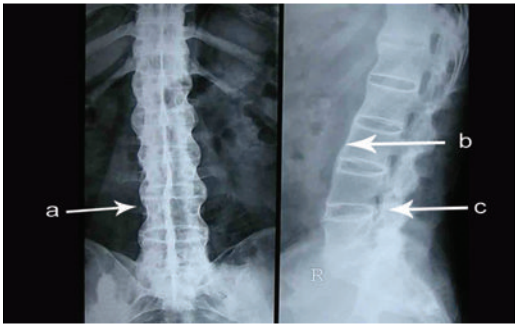


Figure 9.40 AS – X ray lumbar spine (A) Bilateral symmetrical syndesmophytes (bamboo spine). (B) Anterior longitudinal ligament calcification. (C) Fusion of apophyseal joints.

Table 9.7 Differences between RA and AS

	RA	AS
M:F ratio	1:3	3:1
Peripheral joint involvement	Polyarticular, symmetric	Oligoarticular, asymmetric
Spine involvement	Cervical spine only	Whole spine
Sacroiliac joints	Not involved	Characteristically involved
Heel pain	Uncommon	Characteristic
RF	Present	Absent
Eye	Sicca syndrome, scleritis	Anterior uveitis
HLA association	HLA DR1/DR4	HLA-B27

Viva voce

Q1. What are spondyloarthropathies (SpA)?

These are a group of heterogeneous diseases characterized by

- Inflammatory axial spine involvement (sacroiliitis and spondylitis)
- Asymmetric (oligoarticular) peripheral arthritis
- Enthesitis
- Inflammatory eye disease
- Mucocutaneous involvement
- Absence of rheumatoid factor
- Familial aggregation
- Strong association with HLA-B27

Q2. Which diseases are included under the term SpA?

- Ankylosing spondylitis
- Psoriatic arthritis (spondylitic variety)
- Reactive arthritis
- Arthritis associated with inflammatory bowel disease
- Juvenile ankylosing spondylitis
- Undifferentiated spondyloarthropathies

Q3. What is DISH?

It is a degenerative disorder frequently mistaken for AS. Its main distinguishing features are normal disc spaces and apophyseal joints with large ossifications of anterior longitudinal ligament (Fig. 9.41) bridging several vertebrae. It commonly involves cervical and lumbar spine. Sacroiliac joints are not involved.

Q4. What are the causes of arthritis with SI joint involvement?

- Ankylosing spondylitis
- Psoriatic arthritis
- Reactive arthritis
- Arthritis associated with inflammatory bowel disease

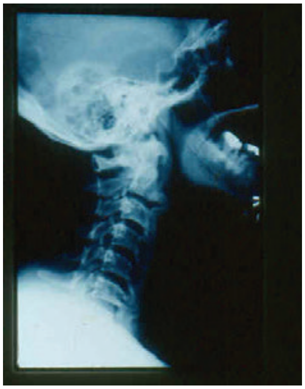


Figure 9.41 Cervical spine X-ray – Anterior longitudinal ligament calcification with normal disc spaces and apophyseal joints (DISH).

- Tuberculosis
- Brucellosis

A case of systemic lupus erythematosus

It is a chronic multisystem autoimmune disorder, predominantly occurring in women.

1. **Clinical manifestations (Fig. 9.42)**
   - **a.** A chronic autoimmune inflammatory disorder, most commonly occurring in young women
   - **b.** Systemic lupus erythematosus can present with pyrexia, a variety of skin rashes (butterfly malar rash characteristic), alopecia, mouth ulcers, lymphadenopathy, renal, pleuropulmonary, cardiac, neuropsychiatric, hematologic and musculoskeletal manifestations, either in isolation or in combination. Active SLE adversely affects pregnancy and fetal outcome. The disease severity varies from mild to a life-threatening disorder.
2. **Cutaneous manifestations**
   - **a.** Facial rash, butterfly rash (Fig. 9.43), subacute lupus.
   - **b.** Palpable purpura, vasculitis lesions on finger tips (like Osler's nodes) and palms (like Janeway lesions) (Fig. 9.44), vasculitic ulcers
   - **c.** Periungual erythema, nail fold lesions (Fig. 9.45), digital infarcts
   - **d.** Livedo reticularis
   - **e.** Raynaud's phenomenon, lupus panniculitis, subcutaneous nodules
   - **f.** Urticaria (vasculitic)

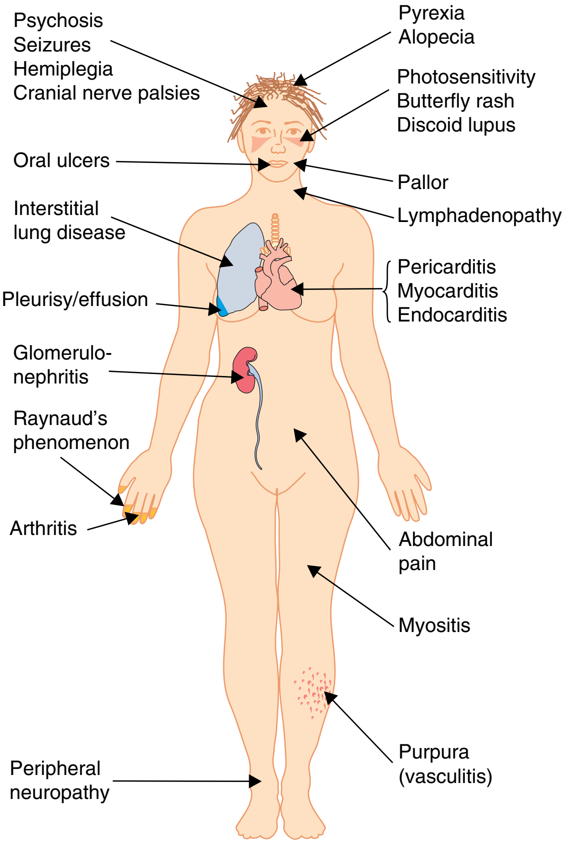
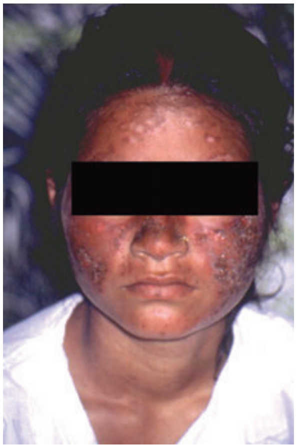

Psychosis
Seizures
Hemiplegia
Cranial nerve palsies
Pyrexia
Alopecia
Photosensitivity
Butterfly rash
Discoid lupus
Oral ulcers
Pallor
Lymphadenopathy
Interstitial lung disease
Pleurisy/effusion
Pericarditis
Myocarditis
Endocarditis
Glomerulo-nephritis
Raynaud's phenomenon
Arthritis
Abdominal pain
Myositis
Purpura (vasculitis)
Peripheral neuropathy

Figure 9.42 Clinical features of SLE.



[redacted]

Figure 9.43 Rash face sparing nasolabial folds.

   - **g.** Alopecia, diffuse or localized, scarring (Fig. 9.46)

Articular – Polyarthritis (similar to RA) but nondestructive and usually nondeforming (Jaccoud's arthritis with reversible joint deformities)

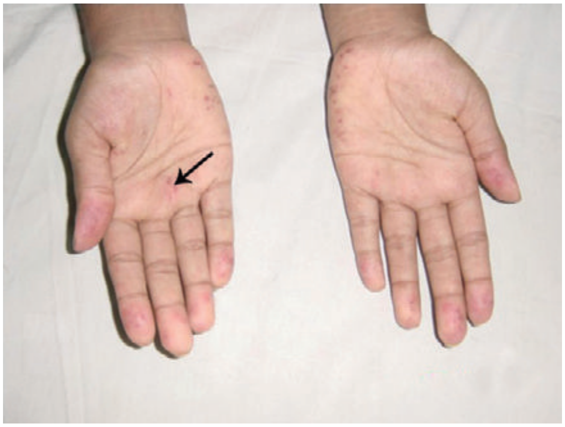


Figure 9.44 Janeway lesions.

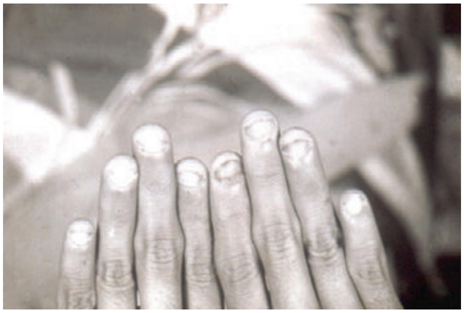


Figure 9.45 Nail fold lesions (infarcts).

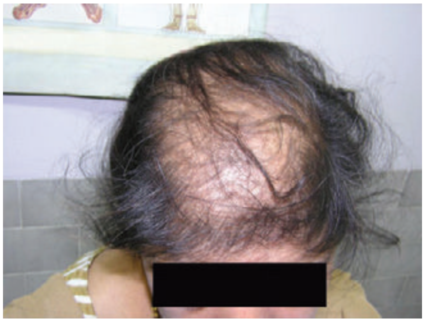


Figure 9.46 Diffuse alopecia.

3. **Diagnosis**
   a. Clinical features plus results of investigations
   b. Presence of ANA ± anti-dsDNA or anti-Sm. Systemic lupus erythematosus is extremely unlikely with negative ANA.
   c. Urine (routine), CBC and serum creatinine periodically. Others as indicated.

4. **Management of SLE**
   a. General measures
      i. Avoid exposure to sun (UV rays) and use high synovial fluid value skin lotions
      ii. Avoid physical and mental stress (ensure adequate rest, sleep)
      iii. Balanced and low salt diet
      iv. Symptomatic treatment of hypertension, congestive cardiac failure, convulsions, psychiatric manifestations
      v. Nutrition, exercise, prophylaxis against osteoporosis
      vi. Chemoprophylaxis and vaccination against opportunistic infections
   b. Specific treatment
      i. Nonsteroidal anti-inflammatory drugs, low dose steroids, chloroquine or hydroxychloroquine for fever, rash, arthritis, arthralgia, myalgia
      ii. Moderate dose steroids for serositis, myositis
      iii. Steroids (high dose), immunosuppressives, plasmapheresis, intravenous immunoglobulin, biologic for severe organ-specific manifestations
      iv. Kidney transplant for end stage renal disease

Viva voce

Q1. What is the differential diagnosis of SLE?

- Rheumatoid arthritis
- Dermatomyositis
- Mixed connective tissue disease
- Systemic vasculitis
- Systemic onset JIA (Still's disease)
- Drug-induced lupus
- Sjögren's syndrome

Q2. What is drug-induced lupus?

It is a lupus-like illness due to drugs, such as chlorpromazine, hydralazine, isoniazid, methyldopa, procainamide. It does not involve CNS and kidneys. Main manifestations are fever, arthralgia/arthritis and serositis. On discontinuation of the drug, there is rapid resolution of symptoms. Treatment is symptomatic and drug discontinuation.

A case of chronic tophaceous gout

Gout is a metabolic disorder caused by precipitation of monosodium urate crystals in tissues, most commonly in and around joints, with acute recurrent attacks (podagra) (Fig. 9.47) or chronic tophaceous gout

1. **Clinical features of chronic tophaceous gout**
    - **a.** Chronic polyarthritis with deformities
    - **b.** Tophi (Fig. 9.48A and B)

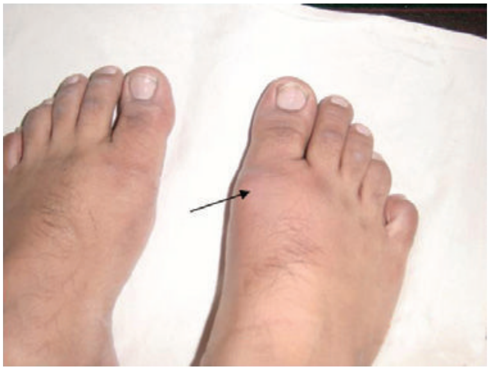


Figure 9.47 Acute attack of gout right great toe.

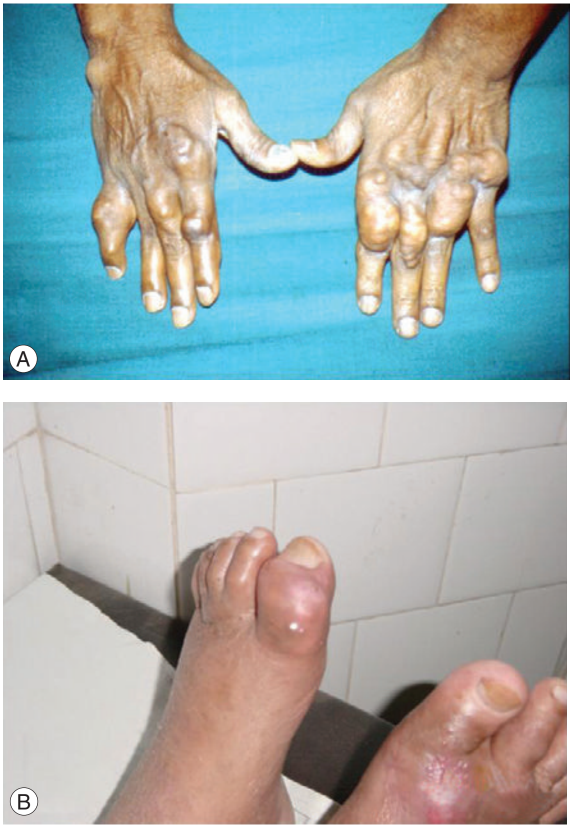


Figure 9.48 (A) Tophi fingers. (B) Discharging tophus left toe.

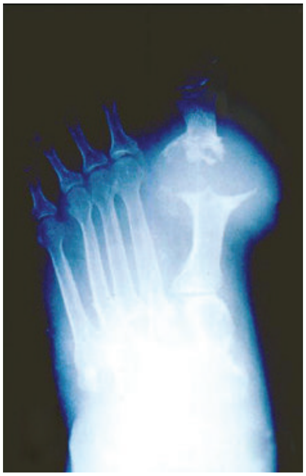


Figure 9.49 X-ray great toe have Tophaceous gout – Soft tissue swelling and large erosions with overhanging edges.

    - **c.** Renal calculi, renal failure
    - **d.** Associated disorders – Hypertension, ischemic heart disease, obesity, dyslipidemia, and diabetes mellitus (DM)
2. **Diagnosis**
    - **a.** Elevated serum uric acid (suggestive but not diagnostic)
    - **b.** Demonstration of phagocytosed or free urate crystals in synovial fluid
    - **c.** Identification of urate crystals in tophus
3. **Radiology**
    - **a.** Acute gout (attack) – Soft tissue swelling
    - **b.** Chronic tophaceous gout (Fig. 9.49)
        - **i.** Soft tissue shadow of tophus with punctuate calcification
        - **ii.** Punched out erosions with overhanging edges
        - **iii.** Bone cysts with sclerotic margins
        - **iv.** Relative preservation of joint space
4. **Treatment (principles)**
    - **a.** Diet – Avoid diet rich in purines
    - **b.** Avoid alcohol
    - **c.** Allopurinol to lower uric acid; aim at serum uric acid level of 5–6 mg/dl
    - **d.** Good fluid intake (greater than or equal to 3 l/day) to ensure good urine output
    - **e.** Colchicine or NSAIDs for acute attack and for prevention of attacks 6 months of uric acid lowering therapy
    - **f.** Treatment of associated conditions

Viva voce

Q1. How do you treat acute gout?

- Control with NSAID, colchicine or steroid
- Not to start or alter the dose of allopurinol during an attack

Q2. Enumerate diets rich in purines.

High purine content foods (avoid totally) – Fish roe, salmon, sardines, gravies, liver, meat extracts, soups, kidney and brain.

Moderate purine content foods (consume occasionally) – Meat, prawn, chicken, pomfret, lobster, green peas, cauliflower, spinach, brinjal, chickoo, custard apple and oat meal.

Recently it has been reported that fructose-containing soft drinks raise serum uric acid level.

Q3. What are the causes of intermittent arthritis?

- Gout (podagra)
- Pseudogout
- Palindromic rheumatism
- Others (hyperlipidemia, relapsing polychondritis).

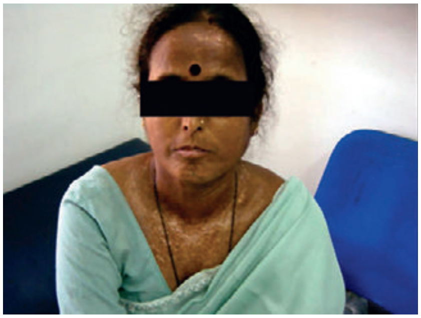

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Figure 9.50 Pigmentary changes of skin (face and chest).

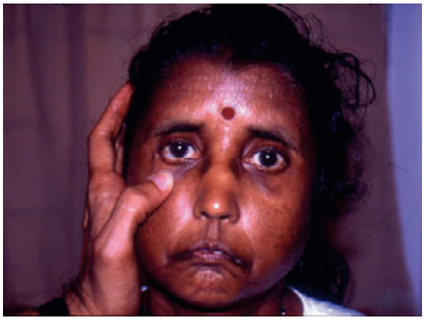

Figure 9.51 Inability to evert lower eyelid.

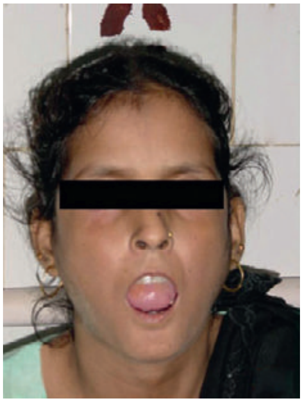
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Figure 9.52 Microstomia.

A case of systemic sclerosis

It is a chronic rheumatic disease characterized by fibrosis involving skin and internal organs (GIT, lungs, heart) and vascular abnormalities.

1. **Clinical features**
    - **a.** Cutaneous manifestations – There are two clinical types:
        - **i.** Limited cutaneous SSc – involves hands, face and neck with late internal organ involvement.
        - **ii.** Diffuse cutaneous SSc – involves proximal skin and trunk with early internal organ involvement.
        - **iii.** There are pigmentary changes, such as pigmentation and depigmentation in both the subtypes (Fig. 9.50).
    - **b.** Face and oral cavity – Inability to evert lower eyelids (Fig. 9.51), microstomia (Fig. 9.52), exaggerated circumoral radial furrowing, telangiectasia, Sjögren's syndrome, atrophy of mucous membrane of tongue, gingivitis and resorption of condyle and ramus of mandible
    - **c.** Hand – Sclerodactyly (Fig. 9.53), Raynaud's phenomenon, nail fold lesions (Fig. 9.54), pitted scars (Fig. 9.55), gangrene, tendinitis, contractures with finger deformities, ulceration, arthritis, telangiectasia, acro-osteolysis and calcinosis
    - **d.** Systemic manifestations – Gastrointestinal tract involvement, mainly esophagus (dysmotility; Fig. 9.56), interstitial lung disease, pulmonary hypertension, carditis, pericarditis, renal crisis and myositis
2. Diagnosis
    - **a.** Clinical features
    - **b.** Antinuclear antibody – Speckled pattern

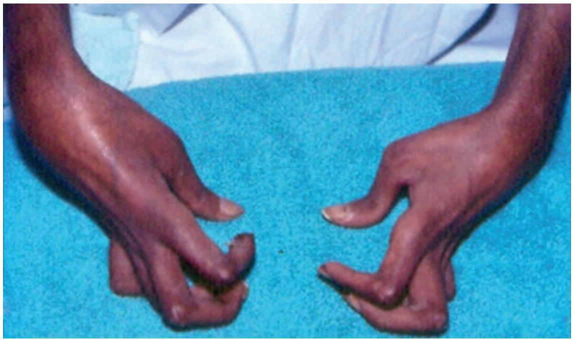

Figure 9.53 Sclerodactyly with flexion contracture of fingers.

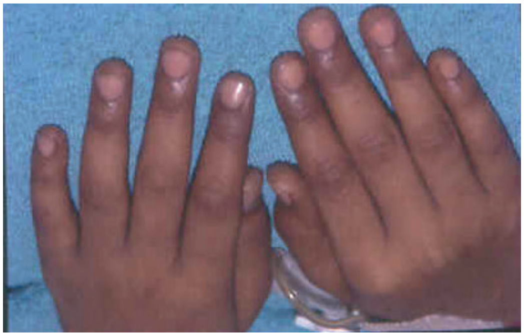

Figure 9.54 Nail fold lesions.

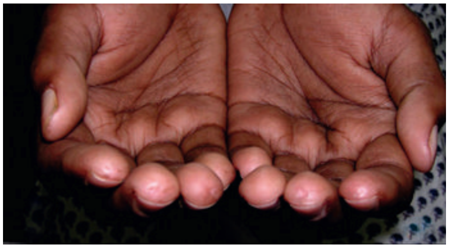

Figure 9.55 Pitted scars on finger tips.

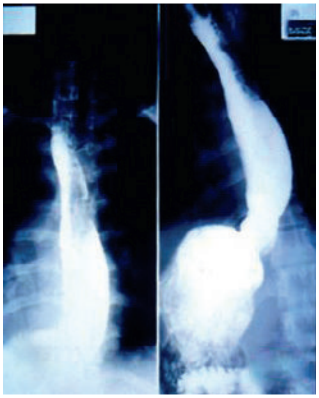

Figure 9.56 Esophagogram – Dilated, hypoperistaltic esophagus.

   - **c.** Anti-Scl 70 or anticentromere antibody (not always present)
   - **d.** Investigations for internal organ involvement
3. Treatment
   - **a.** No curative treatment available
   - **b.** Symptomatic treatment as per symptoms

Viva voce

Q1. What is CREST syndrome?

CREST **(Calcinosis, Raynaud's phenomenon, Esophageal dysmotility, Sclerodactyly and Telangiectasia)** is a type of limited scleroderma.

Q2. How do you treat Raynaud's phenomenon?

- Avoid direct cold contact or exposure. Keep hands warm.
- Peripheral vasodilators – Usually calcium channel blockers
- Others – Fluoxetine and angiotensin-converting enzyme inhibitors
- With severe disease, sympathectomy (cervical or digital), fish oil and antioxidants

A case of osteoarthritis

- Most common arthritis
- A chronic degenerative disorder of joints
- Characterized by progressive loss of joint cartilage along with bony changes and deformities (Fig. 9.57)
- Can be primary or secondary OA
- Can be monoarticular or polyarticular

1. **Clinical features**
   - **a.** Symptoms
     - **i.** Main symptom pain, aggravated by activity

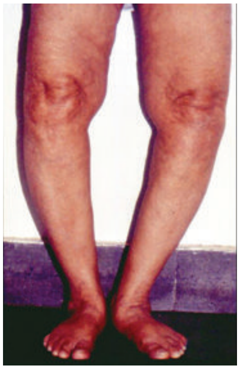

Figure 9.57 Bilateral OA of knees with varus deformity.

    - **ii.** Early morning stiffness or inactivity stiffness of short duration (15–20 minutes)
    - **iii.** Joint swelling
    - **iv.** Limitation of joint movements
    - **v.** Joint deformity
  - **b.** Signs
    - **i.** Most commonly affected joints are shown in Fig. 9.58
    - **ii.** Joint swelling – Bony (occasionally synovial)
    - **iii.** Localized tenderness
    - **iv.** Crepitus on joint movements
    - **v.** Joint instability
    - **vi.** Heberden's and Bouchard's nodes in primary generalized OA
    - **vii.** 'Z' deformity of thumb (squared thumb)

2. X-ray findings (Figs. 9.59 and 9.60)
  - **a.** Asymmetric joint space narrowing
  - **b.** Sclerosis of subchondral bone
  - **c.** Marginal osteophytes

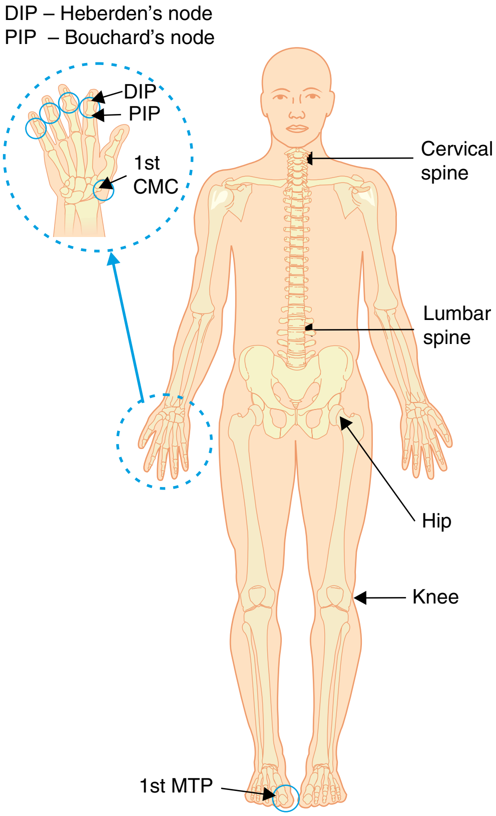

Figure 9.58 Joints commonly affected in OA. DIP, distal interphalangeal; PIP, proximal interphalangeal; MCP, metacarpophalangeal; MTP, metatarsophalangeal.

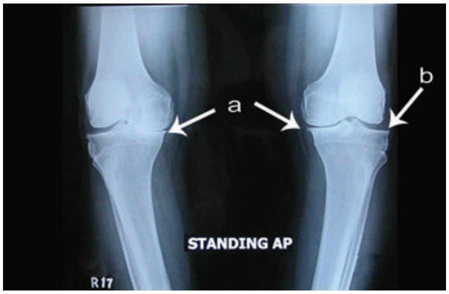

Figure 9.59 X-ray of OA knee. (A) Loss of medial compartment joint spaces. (B) Marginal osteophytes.

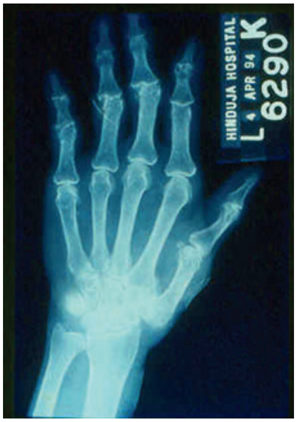

Figure 9.60 X-ray of hands – DIP, PIP, 1st CMC OA.

  - **d.** Subchondral cysts with sclerotic margins
  - **e.** Additionally, there may be deformity, subluxation, loose bodies, juxta-articular calcification

3. Treatment
  - **a.** Weight reduction if over weight
  - **b.** Exercises to improve strength, flexibility, endurance and range of motion
  - **c.** Modification of activities of daily living, e.g. avoid low seats and pillow below knees while sleeping; use of firm bed
  - **d.** Support devises, walking aids
  - **e.** Lateral wedging of footwear (with varus knee)
  - **f.** Drugs – Analgesics, NSAIDs, muscle relaxants, intra-articular corticosteroid (avoid over use) and intra-articular hyaluronan
  - **g.** Glucosamine sulfate, chondroitin sulfate. Benefit unproven
  - **h.** Surgery – Osteotomy, joint replacement

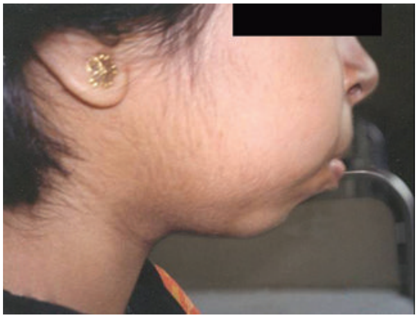
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Figure 9.61 Micrognathia.

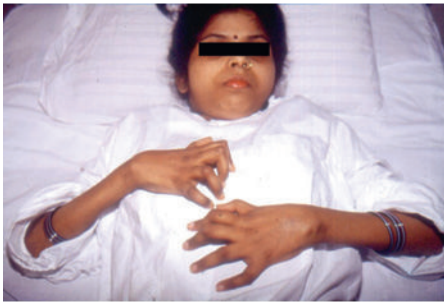
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Figure 9.62 Wrist and finger involvement in polyarticular JIA.

A case of juvenile idiopathic arthritis (juvenile RA)

Juvenile idiopathic arthritis is defined as arthritis that begins before the age of 16 years and persists for at least 6 weeks.

It may manifest as oligoarticular, polyarticular (RF +ve or −ve), systemic (Still's disease) or enthesopathic disorder. In Still's disease, systemic features, such as fever, rash and serositis are prominent in the early stages (arthritis evolves later) with prominent acute phase response.

Main complications are growth disturbances (Fig. 9.61) and amyloidosis. Macrophage activation syndrome is specifically a serious complication of Still's disease. Enthesitis variety is associated with HLA-B27 and may evolve into AS. Polyarticular disease resembles adult RA (Fig. 9.62)

Management

Drug treatment is essentially similar to that in adults except for Still's disease, which often needs steroids for control of systemic features. Education, nutrition and psychological support need special attention.

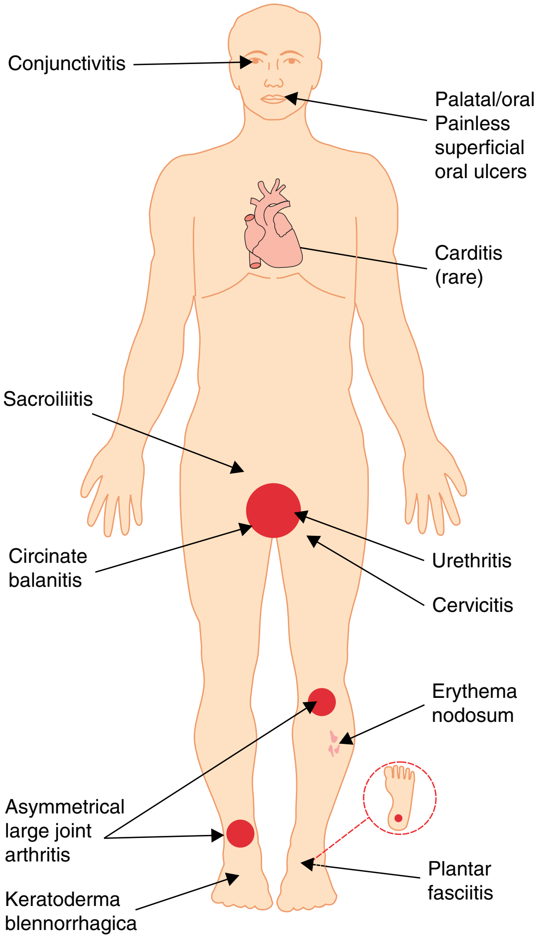
Conjunctivitis
Palatal/oral
Painless superficial oral ulcers
Carditis (rare)
Sacroiliitis
Circinate balanitis
Urethritis
Cervicitis
Erythema nodosum
Asymmetrical large joint arthritis
Plantar fasciitis
Keratoderma blennorrhagica

Figure 9.63 Clinical features of ReA.

A case of reactive arthritis

Reactive arthritis is a systemic disease characterized by sterile inflammation of joints secondary to a distant infection, most commonly gastrointestinal, urogenital or throat. Often, the preceding episode of infection cannot be identified.

1. **Clinical manifestations (see Fig. 9.63)**
2. **Prognosis**
    - **a.** Most patients recover within a few weeks. A small percentage develops chronic arthritis.
    - **b.** Recurrences occur in a few
    - **c.** Some develop AS
3. **Treatment**
    - **a.** Most respond to full doses of NSAIDs
    - **b.** Chronic and recurrent forms are treated with sulfasalazine

Viva voce

Q1. What are the causes of neuropathic joint?

The causes are

- Leprosy
- DM
- Syringomyelia
- Amyloidosis
- Tabes dorsalis
- Meningomyelocele
- Congenital indifference to pain
- Nerve root compression and familial neuropathy

Q2. What are nonmuscular manifestations of dermatomyositis?

The nonmuscular manifestations are

- Gottron's papules (pathognomonic)
- Periorbital heliotrope rash (highly characteristic)
- Dusky facial rash
- Shawl sign
- V sign
- Nail fold erythema
- Mechanic's hands
- Subcutaneous calcification
- Arthritis (mild)
- Vasculitic ulcers
- Fever
- Cardiac involvement
- Pulmonary and GIT involvement.

Q3. What are the musculoskeletal manifestations of leprosy?

The musculoskeletal manifestations are

- Symmetric subacute polyarthritis (part of lepra reaction)
- Chronic arthritis independent of reactive state
- Erythema nodosum leprosum
- Osteolysis
- Claw hand
- Aseptic bone necrosis
- Charcot joint
- Dactylitis and Lucio phenomenon.

Q4. What are the osteoarticular manifestations of tuberculosis?

- Osteomyelitis – Pott's spine being the most common osseous manifestation
- Erythema nodosum, tenosynovitis, dactylitis (Fig. 9.64), Poncet's disease (a reactive state)

Q5. What is antiphospholipid (APL) antibody syndrome?

Antiphospholipid antibody syndrome is a prothrombotic disorder associated with a circulating anticoagulant (lupus anticoagulant). It can be a primary disorder or secondarily associated with other systemic connective tissue disorders (most commonly SLE). It presents with recurrent arterial (Fig. 9.65) and venous thrombosis and recurrent second trimester miscarriages. Livedo reticularis is characteristic.

Diagnosis is confirmed by the presence of anticardiolipin antibodies of IgG or IgM specificities or lupus anticoagulant or antibody to β2GP1.

Treatment requires long-term (lifelong) anticoagulation including heparin and aspirin during pregnancy.

Q6. What is carpal tunnel syndrome (Fig. 9.66)?

- Carpal tunnel syndrome is an entrapment neuropathy of median nerve at the wrist

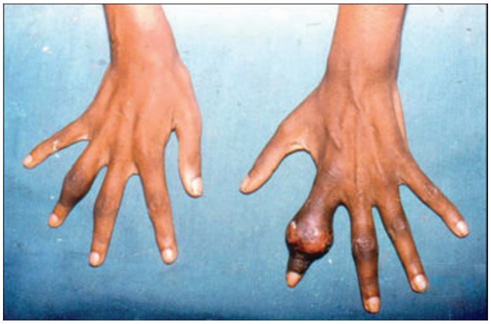

Figure 9.64 TB dactylitis.

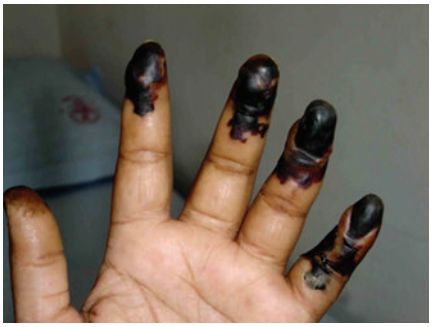

Figure 9.65 Gangrene antiphospholipid (APL) syndrome.

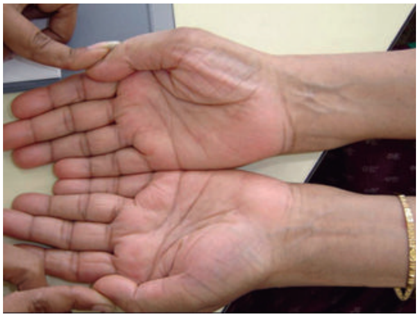

Figure 9.66 Carpel tunnel syndrome – Wasting of thenar muscles.

- Patient complains of nocturnal paresthesias in median nerve distribution. Sensory loss and thenar muscle wasting develop later (Fig. 9.66)
- Tinel's or Phalen's tests are positive
- Nerve conduction studies help to confirm the diagnosis
- Therapy includes avoiding precipitating activities, splints, local steroid injection(s) and surgical decompression
- Important causes are
  - Pregnancy
  - Hypothyroidism
  - Acromegaly
  - RA
  - Work related (e.g. computer operators)
  - Infection (tuberculosis, leprosy)
  - Amyloidosis

Chapter 10

Electrocardiography

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INTRODUCTION

Electrocardiogram (ECG) is a graphic record of electrical activity of the heart. It is a useful tool for diagnosis of conditions, such as acute myocardial infarction (AMI), ischemic heart disease, cardiac arrhythmias, electrolyte disturbances and digitalis toxicity. For a beginner, pattern recognition is very useful. For thorough understanding, one has to learn spatial vectorial analysis. We shall, however, restrict to pattern recognition of common ECG abnormalities.

Conventional ECG

Conventional ECG is recorded at a paper speed of 25 mm/second. One small square (equal to 1 mm) measures 0.04 seconds while one big square (equal to 5 mm) measures to 0.2 seconds. Voltage is measured along vertical axis. In standard ECG, 10 mm deflection is equivalent to 1 mV. Conventionally, 12-lead ECG is recorded (six limb leads and six precordial leads). Electrocardiogram leads are as follows:

Lead I records voltage difference between left arm and right arm.

Lead II records voltage difference between left leg and right arm.

Lead III records voltage difference between left leg and left arm.

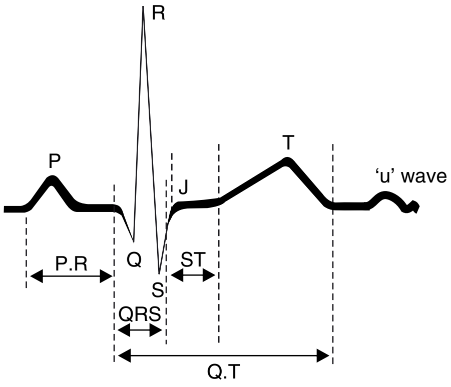


Figure 10.1 Shows normal ECG, waves and intervals. J is S–ST junction point, and U wave is sometimes present normally.

Augmented limb leads (unipolar limb leads) – aVR, aVL and aVF record electrical activity of heart from right arm, left arm and left leg, respectively. **Precordial (leads) (unipolar chest leads)** – These leads record the electrical activity of the heart from different positions which are as follows:
V1 – 4th intercostal space, right sternal border
V2 – 4th intercostal space, left sternal border
V3 – Between V2 and V4
V4 – Left 5th intercostal space, midclavicular line
V5 – Left anterior axillary line in the same horizontal plane as V4
V6 – Left midaxillary line in the same horizontal plane as V4 and V5
Note – V7 (posterior axillary line) and V8 (scapular line) are additional leads but are not used in practice. See Fig. 10.1 showing normal ECG, waves and intervals.

THE DEFLECTIONS

P wave

P wave is due to atrial depolarization. It is the sum of right and left atrial activations (early part of P wave represents right atrial electrical activity and terminal part represents left atrial activity). P wave is upright in most leads except aVR. It is best seen in leads II and V1. In V1, P wave may be biphasic (initial upward deflection is due to right atrial activation and terminal negative deflection is due to left atrial activation). The duration of P wave normally does not exceed 0.10 seconds (2½ small squares), and the amplitude does not exceed 2.5 mm in height (Fig. 10.2).

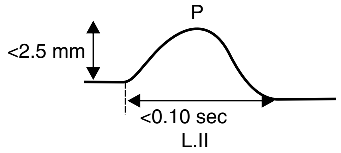


Figure 10.2 Normal P wave.

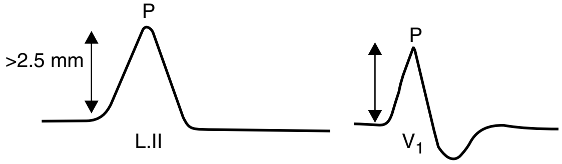


Figure 10.3 Tall P wave (P pulmonale).

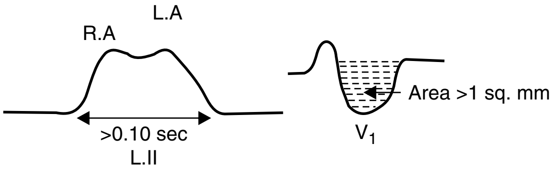


Figure 10.4 Wide bifid P wave (P mitrale).

Conventionally +ve deflection is upward deflection and −ve deflection is downward deflection.

Abnormal P waves

1. Tall P wave (greater than 2.5 mm in height, i.e. greater than 2.5 mV) is called *P pulmonale*. Its causes are right atrial hypertrophy and hypokalemia (Fig. 10.3).
2. Wide P wave (greater than 0.10 seconds in duration) may be notched and is called *P mitrale*. Its causes are left atrial hypertrophy (LAH) and hyperkalemia (P wave is wide and of low amplitude).

Left atrial hypertrophy is also diagnosed by biphasic P wave in V1 with wide (greater than 0.10 seconds) negative deflection (greater than 1 mm in depth) measuring an area of 1 sq. mm (Fig. 10.4).

QRS complex

QRS complex represents the total ventricular muscle depolarization (Fig. 10.5). Except aVR, QRS complexes are upright (upward deflection is more than downward deflection) in most of the ECG leads.

The duration of QRS complex is the total time taken for both the ventricles to be depolarized (N = 0.04 – 0.08 seconds). QRS complex

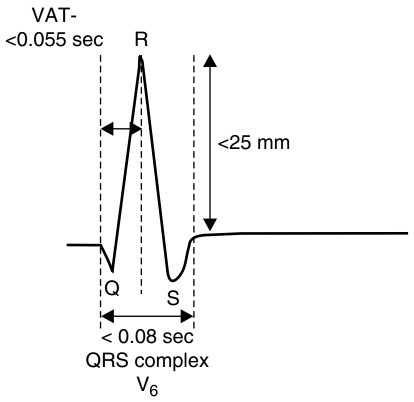


Figure 10.5 Normal QRS complex.

amplitude (sum of upward and downward deflections) (voltage) should be at least 5 mm and more in standard leads, and it should exceed 10 mm in precordial leads. In V1, R wave is smaller than the S wave, and in V6, R wave is taller than the S wave, or S wave may be absent.

1. **q wave** – It is the negative deflection that precedes the R wave. It is due to depolarization of ventricular septum from left to right.
2. **R wave** – It is the first positive deflection of QRS complex. It is due to depolarization of the ventricular mass.
3. **S wave** – It is the first negative deflection of QRS complex that follows the R wave. It is due to depolarization of the posterobasal part of the left ventricle and the uppermost part of the interventricular septum (IVS).

Thus, ventricular depolarization is represented by three waves – ‘q’ septal, ‘R’ main left ventricular mass and ‘S’ posterobasal part of left ventricle and upper part of IVS.

QRS complex voltage abnormalities

High voltage

1. High voltage in lateral chest leads (V4, V5, V6) is seen in left ventricular hypertrophy (LVH). A sum of R wave (in lead V6) plus S wave (in lead V1) greater than 35 mm indicates LVH.
2. In right ventricular hypertrophy (RVH), R wave is greater than 5 mm in V1.

Low voltage

QRS amplitude less than 5 mm in limb leads is defined as low voltage (Fig. 10.6).

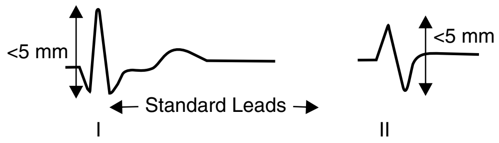


Figure 10.6 Low voltage.

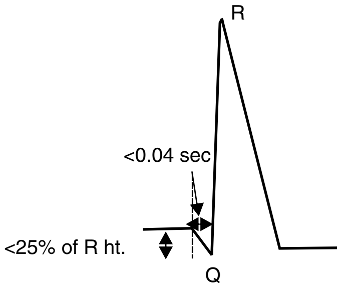


Figure 10.7 Normal Q wave.

Causes of low-voltage QRS complexes are

- Pericarditis with effusion (associated with sinus tachycardia)
- Constrictive pericarditis (associated with sinus tachycardia)
- Myxedema (associated with sinus bradycardia)
- Emphysema (associated with normal heart rate or sinus tachycardia)

Q wave

Q wave is measured in time duration on the horizontal axis while its depth is measured on the vertical axis from the baseline to the nadir of the wave. An entirely negative deflection without an ensuing R wave is termed *QS deflection*. Normal Q wave does not exceed 0.04 seconds in duration and is less than one-fourth of the height of R wave (Fig. 10.7).

Q waves are pathological if any one of the following features is present:

- Greater than 0.04 seconds in duration
- Greater than 25% in depth of the height of the ensuing R wave
- Seen in leads that normally do not have Q waves (e.g. V1)
- QS complex

Pathological or abnormal Q wave signifies myocardial necrosis and myocardial infarction (Fig. 10.8).

T wave

It is due to ventricular repolarization and follows QRS complex. Usually T wave is upright in most of the leads except aVR (i.e. it is in the same direction as the main QRS complex; Fig. 10.9).

Significance of flattening of the T wave (Fig. 10.10) is similar to that of T wave inversion (Fig. 10.11). T wave inversion is usually accompanied with ST segment depression, together these are labeled as *ST–T changes*.

Specific T wave inversion

Primary T wave inversion – symmetrical, sharp and peaked apex (Fig. 10.12). It is seen in

- Ischemic heart disease (AMI, acute coronary insufficiency)
- Myocarditis, cardiomyopathy
- Pericarditis (acute pericardial effusion, constrictive pericarditis)
- Hypokalemia
- Digitalis or quinidine toxicity

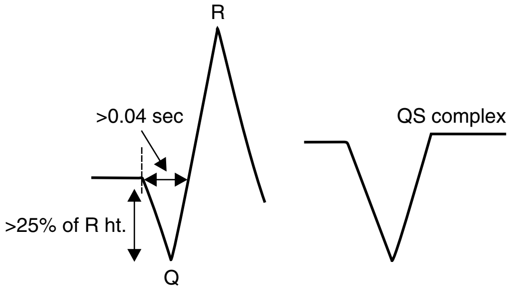


Figure 10.8 Pathological Q waves.

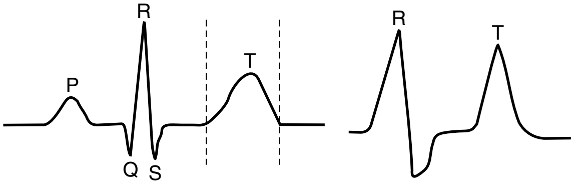


Figure 10.9 Normal T wave.

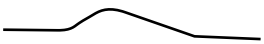


Figure 10.10 Flat T wave.

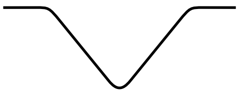


Figure 10.11 T wave inversion.

Secondary T wave inversion – asymmetric with steeper distal ascending limb than the proximal descending limb and a blunt apex (Fig. 10.13). It is seen in

- Left ventricular hypertrophy (LVH strain)
- Bundle branch block (BBB)
- Wolff-Parkinson-White (WPW) syndrome

Tall T wave

Normal amplitude of T wave in limb leads is up to 5 mm and in precordial leads it is up to 10 mm. T wave greater than 10 mm in height is called *tall T wave.*

Causes of tall T wave

1. Hyperkalemia (Fig. 10.14)
2. Myocardial injury/ischemia (Fig. 10.15)
    - Prinzmetal's angina
    - Hyperacute MI
    - Acute coronary insufficiency
3. True posterior wall myocardial infarction (present in V1, V2 and V3)
4. Normal variant (in vagotonic persons)

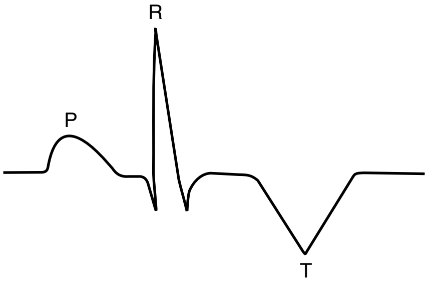


Figure 10.12 Primary T wave inversion.

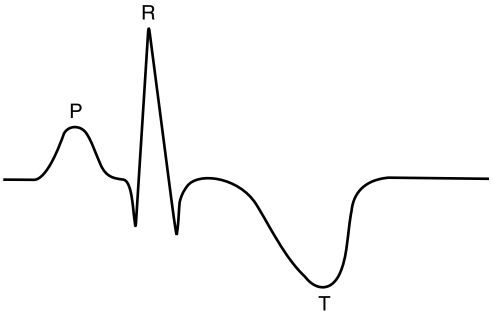


Figure 10.13 Secondary T wave inversion.

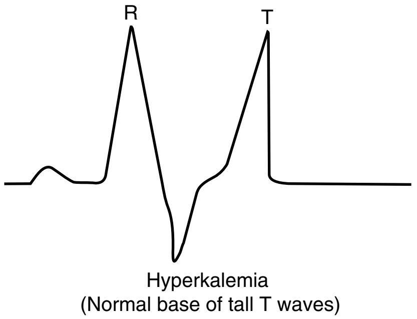


Figure 10.14 Tall T wave.

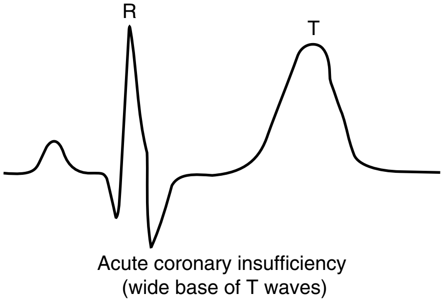


Figure 10.15 Tall T wave.

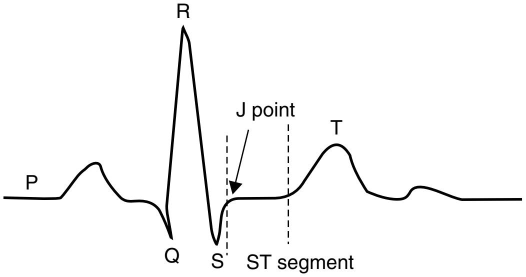


Figure 10.16 Normal ST segment.

The two commonest causes of tall T wave in precordial leads are hyperkalemia and hyperacute MI.

Hyperkalemia being a metabolic abnormality, tall T wave are seen in nearly all leads and most clearly in precordial leads. In acute coronary insufficiency, tall T wave are seen in the leads reflecting the ischemic area of myocardium.

ST segment

ST segment is part of the ECG tracing from the J point (end of QRS complexes and beginning of ST segment) to the onset of T wave. Normally, ST is at the same level as the PR segment (the isoelectric line; Fig. 10.16). ST segment may be depressed or elevated in relation to the PR segment.

ST segment depression

The depression of ST segment is measured in relation to TP segment or PR segment, and any depression greater than 0.5 mm with or without T wave change is considered significant. ST depression may be primary or secondary.

Primary

1. Ischemic heart disease (horizontal depression) (Fig. 10.17)
2. Myocardial disease, e.g. myocarditis, cardiomyopathy
3. Hypokalemia (sagging depression) (Fig. 10.18)
4. Drugs, e.g. digitalis effect (hockey stick depression) (Fig. 10.19), quinidine toxicity

Secondary

1. Left ventricular hypertrophy or LV systolic overload (strain pattern)
2. Bundle branch block
3. Wolff-Parkinson-White syndrome

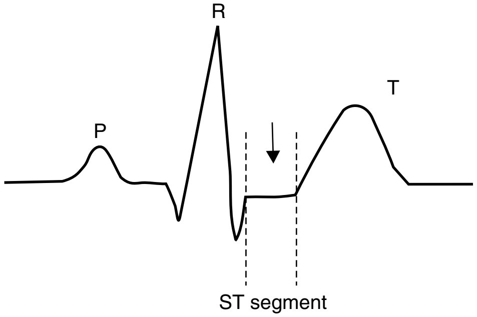


Figure 10.17 Depressed horizontally (ischemic heart disease).

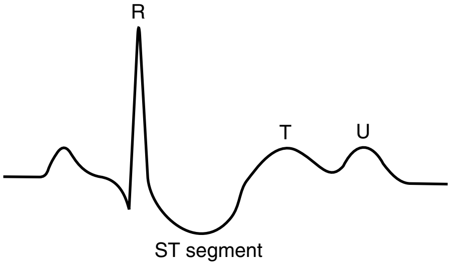


Figure 10.18 Sagging depression (hypokalemia).

ST segment depression due to digitalis effect (not toxicity) has hockey stick appearance and is usually present in leads I, aVL, V5 and V6; in digitalis toxicity, it is present practically in all leads. In myocardial ischemia and myocardial disease, ST segment depression can be seen as horizontal depression or sagging depression.

ST segment elevation

When ST segment is elevated by greater than 1 mm in relation to TP or PR segment, it is invariably abnormal. The causes of ST segment elevation are

- Acute myocardial infarction (Fig. 10.20)
- Evolving phase of AMI (Fig. 10.21)
- Dressler's syndrome
- Prinzmetal's angina
- Ventricular aneurysm
- Early repolarization (normal variant) (Fig. 10.22)

Elevated ST segment can have two patterns

1. Coved up pattern – Suggests ischemia (Fig. 10.23).
2. Coved down pattern – Seen in acute pericarditis (Fig. 10.24).

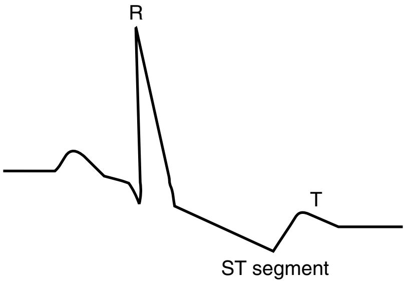


Figure 10.19 Hockey stick type depression (digitalis effect).

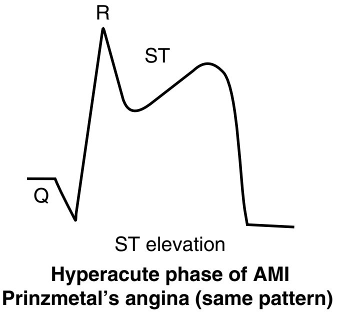


Figure 10.20 Acute myocardial infarction.

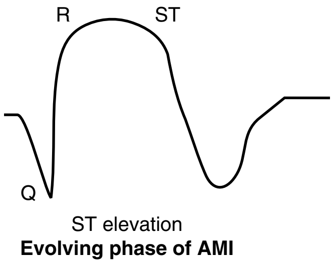


Figure 10.21 Acute myocardial infarction.

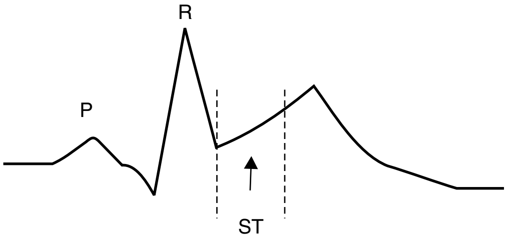


Figure 10.22 Elevated ST segment (early repolarization).

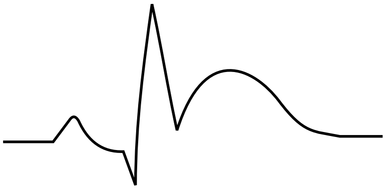


Figure 10.23 Coved up ST segment elevation (acute ischemia).

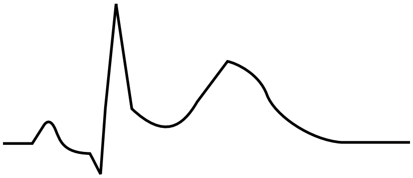


Figure 10.24 Coved down ST segment elevation (acute pericarditis).

U wave

It is a small positive deflection that follows T wave and is due to late repolarization of the ventricular Purkinje fibers. It is usually visible in precordial leads (V2–V4) (Fig. 10.25).

Prominent U waves

These are high amplitude U waves, almost resembling T waves (Fig. 10.26). These are seen in

1. Hypokalemia
2. Cerebrovascular events, e.g. subarachnoid hemorrhage
3. Drug toxicity, e.g. digitalis, quinidine, amiodarone

PR interval

PR interval is the measure of atrioventricular (AV) conduction time. Normal PR interval is 0.12–0.20 seconds (Fig. 10.27). PR interval greater than 0.20 seconds is considered prolonged. PR interval is dependent on heart rate (short with tachycardia and prolonged with bradycardia).

Causes of prolonged PR interval

- Acute rheumatic fever, diphtheria
- Ischemic heart disease
- Congenital heart disease (endocardial cushion defects)
- Hyperkalemia, hypokalemia
- Drugs e.g. digitalis, β-blockers
- Myxedema
- Hypothermia

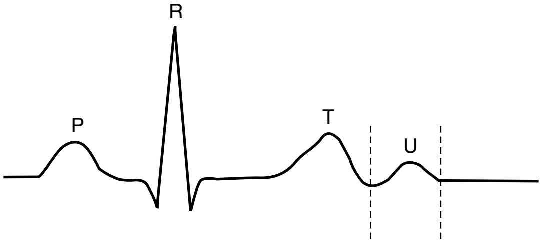


Figure 10.25 Normal U wave.

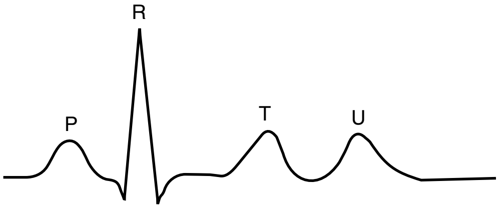


Figure 10.26 Prominent U wave.

Causes of short PR interval (less than 0.12 seconds)

- Nodal rhythm when P wave is inverted and precedes QRS complexes
- Accessory bypass tract (WPW syndrome)
- Vagolytic drugs, e.g. atropine

QT interval

It is the interval between the onset of the Q wave and the end of T wave. QT interval measures the total duration of electrical activity of the ventricles (ventricular depolarization and repolarization).

Normal QT interval is 0.38 ± 0.04 seconds (Fig. 10.28). QT interval shortens with tachycardia and lengthens with bradycardia. Hence for correct interpretation of the QT interval, it must be corrected for heart rate. Corrected QT interval (QT_c) is calculated by the formula

$$QT_c = \frac{\text{QT in seconds}}{\text{RR interval in seconds}}.$$

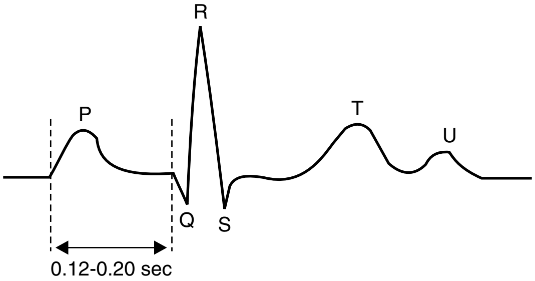


Figure 10.27 Normal PR interval.

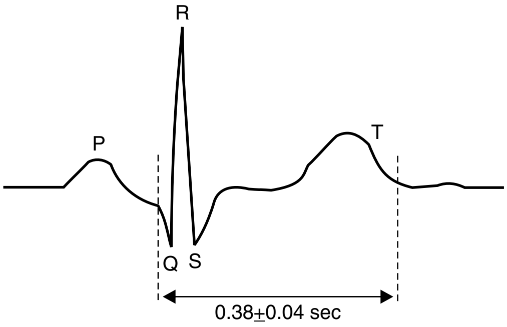


Figure 10.28 Normal QT interval.

Causes of short QT interval

- Digitalis effect
- Hyperkalemia
- Hypercalcemia
- Hyperthermia
- Acidosis

Causes of prolonged QT interval

- Rheumatic fever, acute myocarditis
- Acute myocardial infarction
- Hypocalcemia
- Hypothermia
- Marked sinus bradycardia, complete heart block
- Increased intracranial tension
- Drugs, e.g. quinidine, procainamide, amiodarone.
- Mitral valve prolapse (Barlow's disease)
- Jervell–Lange-Nielson syndrome (autosomal recessive with deafness)

Electrical axis

There are various methods for determination of QRS axis, but hexaxial system is the most popular and easy method. Keep in mind the hexaxial system comprising of three standard and three unipolar limb leads (Fig. 10.29).

Identify the lead with the smallest or equiphasic deflection. The electrical axis has to be at right angles to the lead with minimal deflection. This lead will show the maximum deflection, and the direction of this maximum deflection will give the electrical axis. For example, in a given ECG, if the minimum deflection is in lead II, the axis should be parallel to lead aVL which shows prominent negative deflection; hence the QRS axis would be −30°.

- Normal QRS axis – +90° to −30°
- Left axis deviation – −30° to −90°
- Right axis deviation – +90° to +150°

Causes of left axis deviation

- Elderly
- Left ventricular hypertrophy
- Incomplete left anterior hemiblock (LAHB) or left bundle branch block (LBBB)
- Inferior wall MI
- Ostium primum atrial septal defect (ASD)

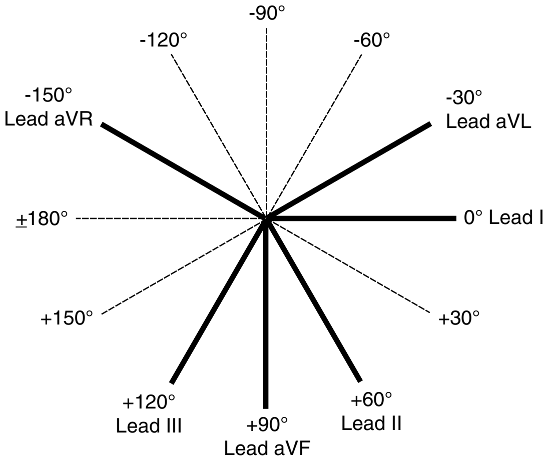


Figure 10.29 The hexaxial system.

Causes of right axis deviation

- Infants and young children
- Incomplete left posterior hemiblock (LPHB) or right bundle branch block (RBBB)
- Right ventricular hypertrophy
- Lateral wall MI
- Mirror-image dextrocardia

Ventricular hypertrophy

Left ventricular hypertrophy

It can be diagnosed by

1. **Voltage criteria**
   - Sum of 'S' in V_1 and 'R' in V_6 greater than 35 mm
   - 'R' in V5/V6 greater than 27 mm (Fig. 10.30)
   - R wave in aVL greater than 11 mm (Fig. 10.31)

   The leads V1, V5 and V6 are important to assess the LVH.
2. **Strain pattern** – It is seen in ECG as ST–T change in leads I, aVL, V5 and V6. There is ST segment depression and asymmetrical inversion of the T waves in above leads.
3. **Delayed intrinsicoid deflection** – Due to LVH intrinsicoid deflection (beginning of QRS complex to the apex of the R wave) is greater than 0.055 seconds (Fig. 10.30).
4. **Left axis deviation** – –30° to –90°.

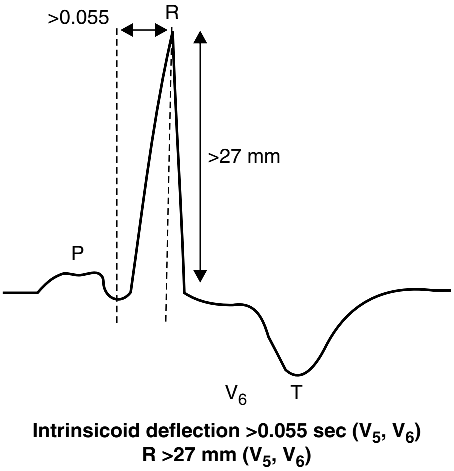

>0.055
R
>27 mm
P
V6
T
Intrinsicoid deflection >0.055 sec (V5, V6)
R >27 mm (V5, V6)

Figure 10.30 Left ventricular hypertrophy.

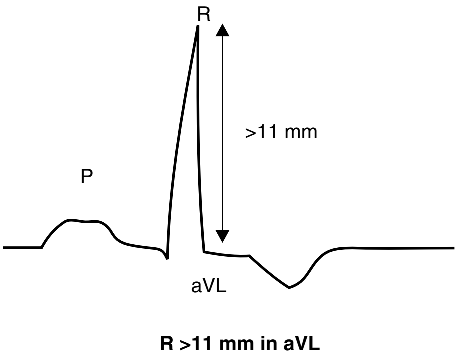

R
>11 mm
P
aVL
R >11 mm in aVL

Figure 10.31 Left ventricular hypertrophy.

Right ventricular hypertrophy

1. **Voltage criteria**
    - R/S ratio greater than 1 in V1
    - R wave greater than 5 mm in V1 (Fig. 10.32)
    - Sum of R in V1 plus S in V6 greater than 10 mm
2. **Strain pattern** – Due to increased wall tension produced by RVH, ST segment depression and T wave inversion are seen in right precordial leads (V1 and V2). It is a feature of systolic overload.
3. **Delay in intrinsicoid deflection** – Intrinsicoid deflection is greater than 0.035 seconds in leads V1 and V2 (Fig. 10.33).
4. **Right axis deviation** – The QRS axis is greater than +110°. Often, there is clockwise rotation and vertical heart position.

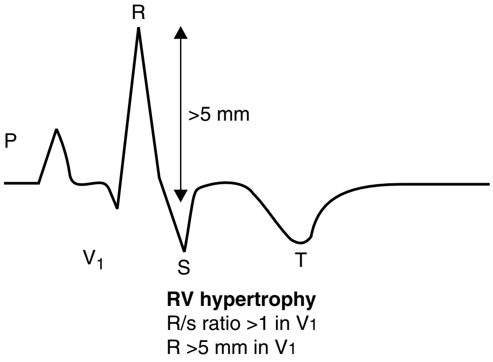

R
>5 mm
P
V1
S
T
RV hypertrophy
R/s ratio >1 in V1
R >5 mm in V1

Figure 10.32 ECG pattern of RV hypertrophy.

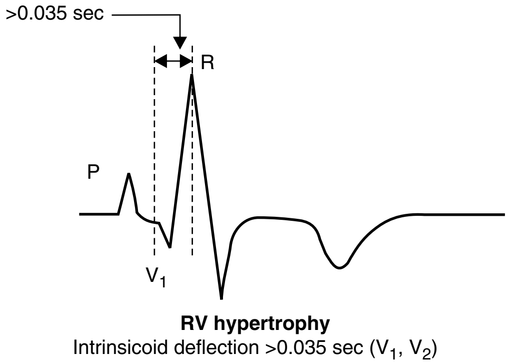

>0.035 sec
R
P
V1
RV hypertrophy
Intrinsicoid deflection >0.035 sec (V1, V2)

Figure 10.33 ECG pattern of right ventricular hypertrophy.

CONDUCTION SYSTEM OF HEART

Conduction system of heart is made of special conduction tissue (Fig. 10.34). The cardiac impulse originates in sinoatrial (SA) node and then traverses across atria to AV node and then to bundle of His, bundle branches (right and left) and terminal Purkinje fibers. The right bundle branch runs along the right side of the ventricular septum and the left bundle branch runs along the left side of the ventricular septal surface. The terminal parts of bundle branches are interconnected in a network of Purkinje fibers.

Bundle branch block

Left bundle branch block

There is a delay in conduction in the left main branch of bundle of His or simultaneously in both its anterior and posterior fascicles.

ECG features

Wide QRS complex

QRS complex exceeds 0.12 seconds. R wave is usually notched or M shaped in leads I, aVL and V6 with deep S wave in V1. The ventricular activation time (VAT) is prolonged, hence onset of intrinsicoid deflection is delayed by more than 0.09 seconds (Fig. 10.35).

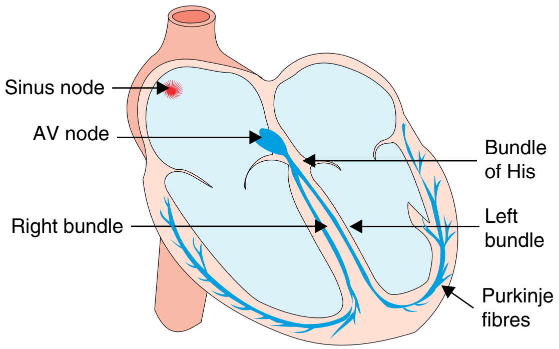

Sinus node
AV node
Right bundle
Bundle of His
Left bundle
Purkinje fibres

Figure 10.34 Conduction system of heart.

ST–T changes

The ST segment is depressed, and T wave is inverted in leads showing upright QRS complexes and upright in leads with downward QRS complexes.

Incomplete LBBB

Electrocardiogram pattern is similar to complete LBBB except the RSR width is 0.10–0.12 seconds and the VAT is less than 0.09 seconds.

Right bundle branch block (RBBB)

It denotes a delay or conduction block in the right branch of the bundle of His.

ECG features

- rSR^1 pattern in V1 shows M-shaped broad complexes and broad, slurred S waves in V5 and V6 (Fig. 10.36). R^1 wave in V1 and S wave

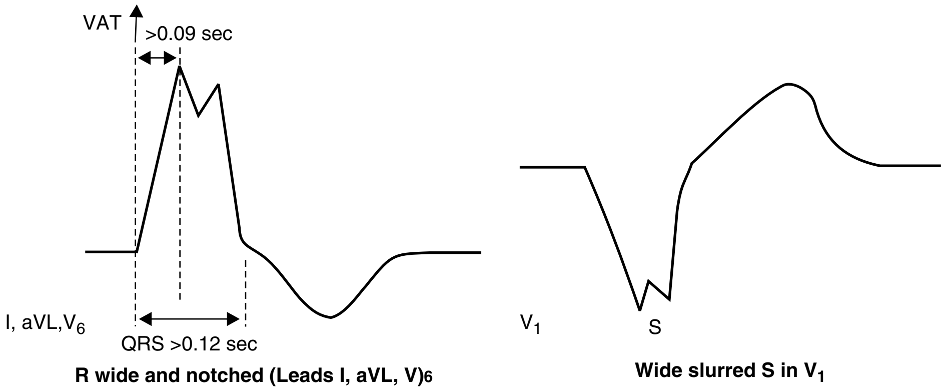

VAT
>0.09 sec
I, aVL,V6
QRS >0.12 sec
R wide and notched (Leads I, aVL, V)6
V1
S
Wide slurred S in V1

Figure 10.35 LBBB.

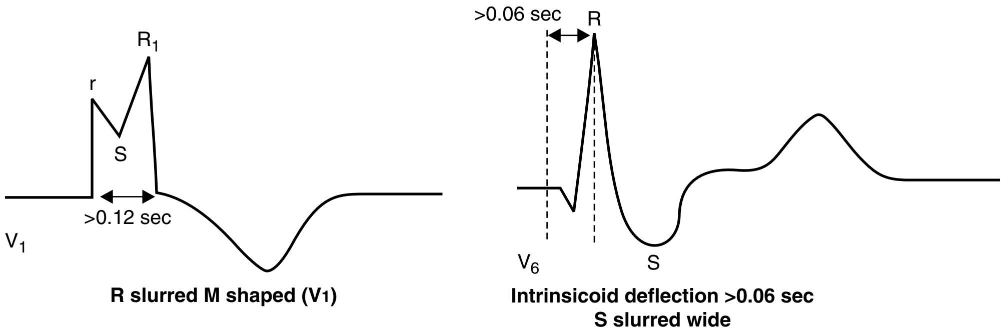

R1
r
S
>0.12 sec
V1
R slurred M shaped (V1)
>0.06 sec
R
V6
S
Intrinsicoid deflection >0.06 sec
S slurred wide

Figure 10.36 RBBB.

in V6 are due to delayed activation of the right ventricle. The width of the QRS complex is greater than 0.12 seconds and VAT is greater than 0.06 seconds.

- ST–T changes – Secondary ST–T changes with T wave in opposite direction of QRS complex.

Incomplete right bundle branch block

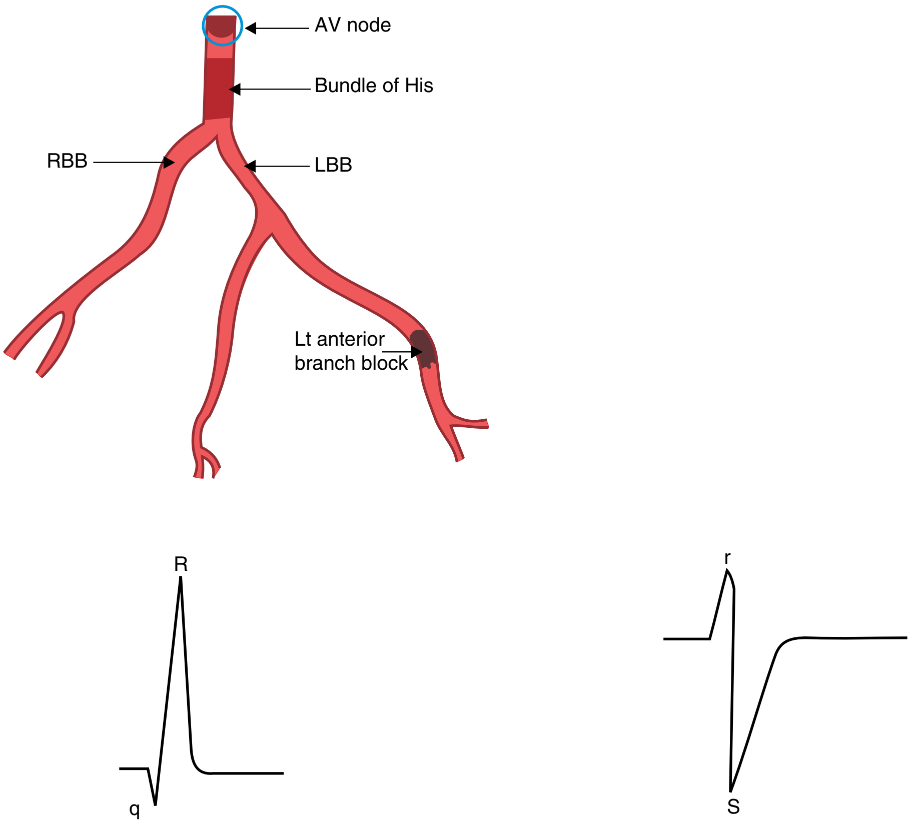
The ECG changes are similar to complete RBBB, but rSR^1 width is less than 0.12 seconds and VAT is less than 0.06 seconds.

Left anterior hemiblock

This is due to delay or conduction block in the left anterior fascicular branch.

ECG features of LAHB

- Dominant R wave (qR pattern) in leads I, aVL and deep S wave (rS pattern) in leads III and aVF (Fig. 10.37)
- Left axis deviation (−30° to −90°)
- Wide QRS complex (QRS width 0.09–0.10 seconds)
- Prolonged VAT (due to impaired conduction in the anterior fascicle)



Dominant R wave (qR pattern in I, aVL)

Deep S wave (rS pattern) in III, aVF

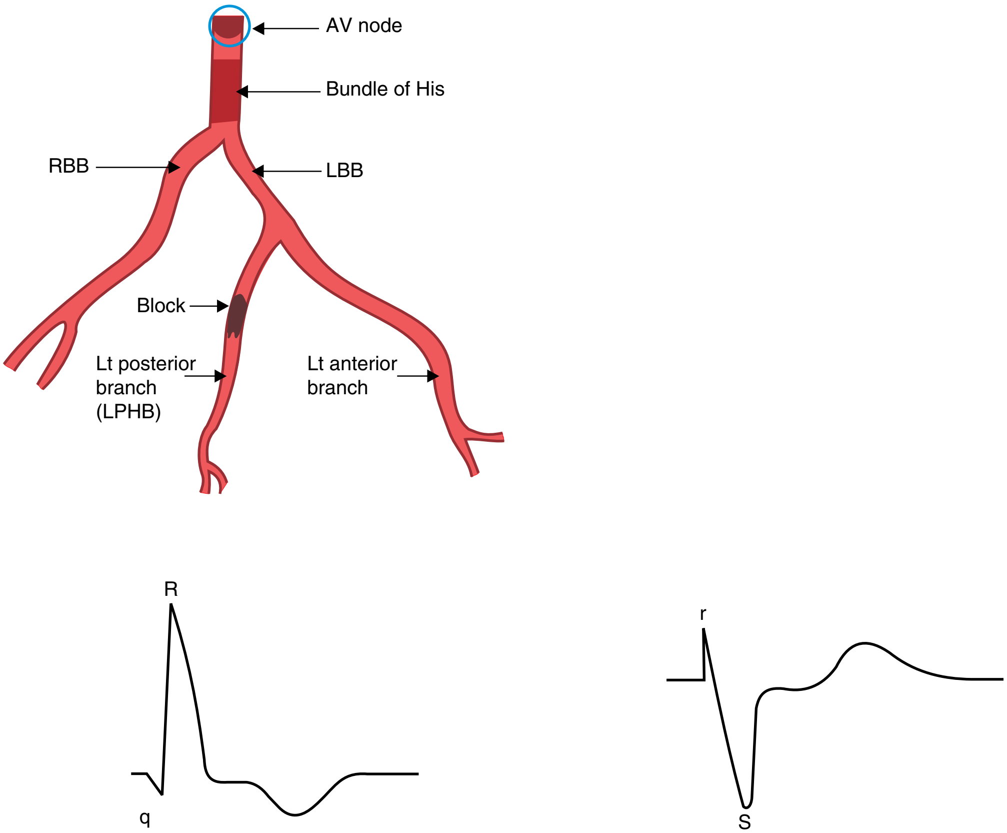
Figure 10.37 Left anterior hemiblock.

Left posterior hemiblock

It results from delay or block in conduction in the posterior fascicle of left bundle.

ECG features of LPHB

- qR pattern in leads III and aVF. Dominant R (qR wave) in leads III and aVF and deep S wave (rS complex) in leads I and aVL (Fig. 10.38)
- Right axis deviation (greater than +110°)
- Wide QRS complex (QRS width is 0.09–0.10 seconds)
- Prolonged VAT (due to impaired conduction in posterior fascicle)



Dominant R(qR) in leads III, aVF

Deep S wave (rS complex) in leads I, aVL

Figure 10.38 Left posterior hemiblock.

- Generally accompanied with RBBB or inferior wall MI
- Left posterior hemiblock is invariably of organic origin

Nodal block

Sinoatrial block

This is an exit block; the impulse cannot exit from the pacemaker (SA node). Failure of impulse formation in the SA node is known as *sinus arrest*. It is not possible to differentiate between SA exit block and sinus arrest (Fig. 10.39).

Atrioventricular **block is classified as**

1. First-degree AV block
2. Second-degree AV block
    a. Mobitz type-I
    b. Mobitz type-II
3. Third-degree (complete) AV block

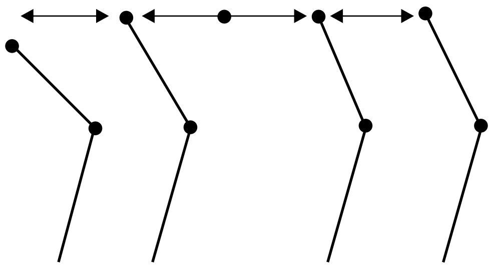


Figure 10.39 Dropped beat. Sinoatrial block (exit block).

First-degree (1°) AV block

There is delay in AV conduction resulting in increased PR interval (greater than 0.2 seconds; Fig. 10.40). Rhythm is regular, and there are no dropped beats. Its causes are

- Acute rheumatic fever, diphtheria (myocarditis)
- Ischemic heart disease

- Drugs (digitalis, β-blockers)
- Congenital heart disease (Ebstein's anomaly and endocardial cushion defect)

Second-degree (2°) AV block

QRS complexes are dropped at regular intervals, e.g. after two atrial (P waves) contractions, there is one ventricle contraction (QRS; 2:1 AV block). It can be 3:1 or 4:1 AV block (Fig. 10.41).

Mobitz type-I block

There is progressive increase in PR interval with successive complexes till a P wave is not followed by QRS complex. After the dropped beat, PR interval again shortens only to repeat the cycle (Fig. 10.42). This is known as Wenckebach phenomenon. Digitalis toxicity is its classical cause.

Mobitz type-II block

The PR interval remains constant, but QRS complexes are intermittently dropped (Fig. 10.43).

As right coronary artery supplies AV node in 90% of individuals, Mobitz type-II block is usually seen with inferior wall MI.

Third-degree (3°) AV block

There is complete interruption of AV conduction. Atria and ventricles beat regularly but independently. No sinus beat (SB) gets conducted to the ventricles.

ECG features

- There is AV dissociation. P waves are unrelated to the QRS complexes.
- P waves occur at regular intervals at the sinus rate of 70–80 per minute but the rate of QRS complexes depends upon the level of AV block. If the block is at the AV node, the lower pacemaker at His bundle discharges at 40–60 beats/minute with relatively narrow QRS complexes (idiojunctional rhythm; Fig. 10.44), but if the lower pacemaker is in distal His Purkinje system, the ventricular

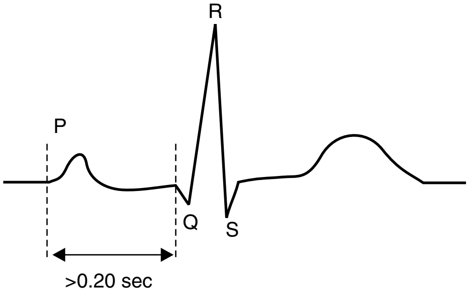


Figure 10.40 1° AV block – Prolonged PR interval greater than 0.20 seconds, no dropped beats.

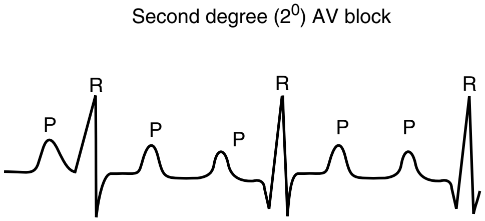


Figure 10.41 2:1 AV block. QRS dropped at regular intervals, two atrial (P wave) followed by one ventricular QRS complex (it can be 3:1 or 4:1).

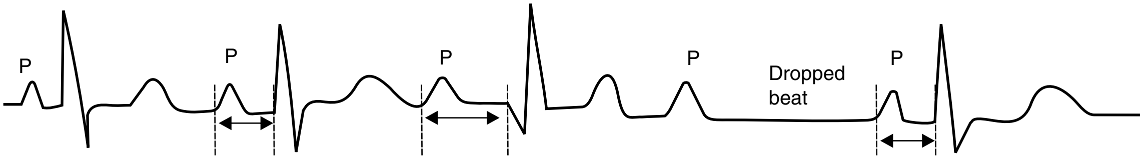


Figure 10.42 Mobitz type-I AV block (Wenckebach phenomenon).

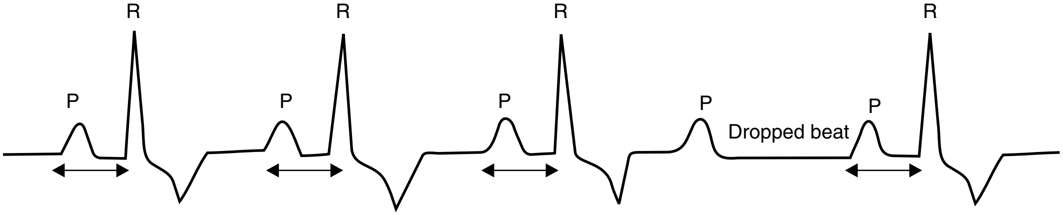


Figure 10.43 Mobitz type-II AV back. PR interval constant intermittent dropped beats.

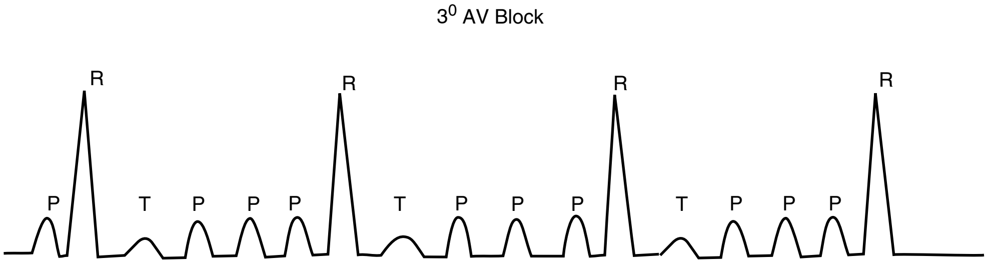


Figure 10.44 Idiojunctional rhythm. Normal QRS complexes with upright T waves; sinus rate (70–80/minute) and ventricular rate (40–60/minute).

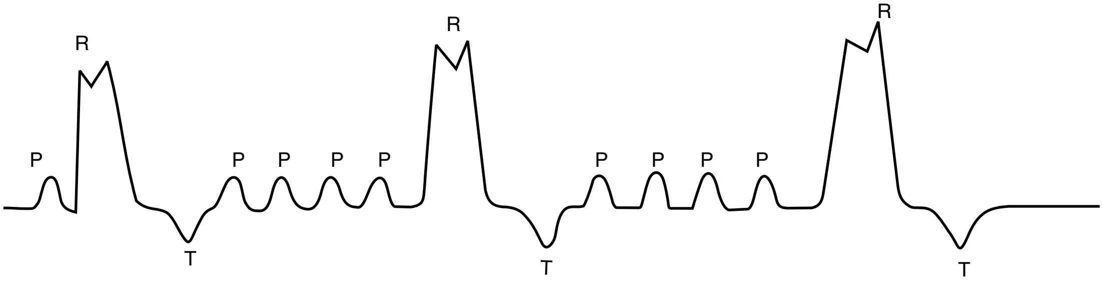


Figure 10.45 Idioventricular rhythm. Wide QRS complexes with T inversion sinus rate (70–80/minute) and ventricular rate (30–40/minute).

rate is slow (30–40 minutes) and the QRS complexes are wide (idioventricular rhythm; Fig. 10.45).

Causes of 3° AV block

1. Coronary heart disease (inferior wall MI or right coronary artery spasm)
2. Congenital heart disease – ostium primum ASD, corrected transposition of great vessels
3. Following cardiac surgery (ventriculo-septal defect repair)
4. Calcific aortic stenosis (AS)
5. Congenital AV block
6. Fibrocalcareous disease (Lev's disease), sclerodegenerative disease (Lenegre's disease)

Arrhythmias

Sinus tachycardia

Sinoatrial node discharges at a rate of 90/minute or more.

Electrocardiographic diagnosis is simple as it is characterized by normal sinus PQRS–T complexes at a rapid rate. Sinus tachycardia needs to be differentiated from the following.

Table 10.1 Differences between PAT and sinus tachycardia

	PAT	Sinus tachycardia
Rate	160–210/minute	Less than 160/minute
P waves	Different from sinus P waves	Sinus P waves
Regularity	Very regular. No alteration with respiration	Slight irregularity during breathing
Onset and termination	Abrupt onset and sudden termination	Gradual increase and gradual slowing
Effect of carotid artery pressure	Sudden reversal	Gradual slowing

Paroxysmal atrial tachycardia

Table 10.1 shows the difference between paroxysmal atrial tachycardia (PAT) and sinus tachycardia.

Junctional tachycardia

For details, see page 318.

Atrial flutter with 2:1 AV block

For details see below.

Sinus bradycardia

Sinoatrial node discharges impulses at a rate less than 60 beats/minute in sinus bradycardia.

Electrocardiographic diagnosis is simple as it consists of normal PQRS–T complexes at a slow rate (less than 60/minute).

Sinus arrhythmia

Sinus arrhythmia is diagnosed by alternating periods of slow and rapid SA node discharge, producing a slightly irregular sinus rhythm. Usually, this occurs due to respiratory phases leading to variations in vagal tone. Sinus rate increases during inspiration and decreases during expiration.

Atrial arrhythmias

Atrial premature complexes

Atrial premature complexes (APCs) arise as a result of premature discharge of an ectopic focus located in atrial myocardium. These are also known as premature atrial extra systoles. The premature impulse activates the atria and then passes through the AV node to activate the ventricles. It also prematurely discharges the SA node thus momentarily depressing its automaticity. The sinus beat following the APC is therefore slightly delayed. There is, however, no compensatory pause (Fig. 10.46).

Paroxysmal atrial tachycardia

It is a fast and regular rhythm due to rapid discharge of an ectopic atrial focus or a reentrant circuit producing rapid atrial excitation. A series of three or more consecutive APCs comprises an atrial tachycardia (Table 10.1).

Atrial flutter

Atrial flutter (AF) is due to rapid and regular atrial excitation (F waves resembling sawtooth appearance) with a regular ventricular rate of 2:1, 3:1 or 4:1 ratios (Fig. 10.47). Atrial flutter is invariably associated with organic heart disease. The causes of AF are

- Rheumatic heart disease
- Hyperthyroidism
- Cardiomyopathy, myocarditis, pericarditis
- Wolff-Parkinson-White syndrome
- Pulmonary embolism

Atrial fibrillation

It is a totally irregular, fast atrial rhythm with an irregular ventricular response. Atrial activation is chaotic and ineffectual; although 400–600 impulses reach AV node, only a few (100–160) impulses activate the ventricles.

Causes of persistent atrial fibrillation

- Rheumatic heart disease (mitral and tricuspid valve diseases)
- Ischemic heart disease
- Congenital heart disease (ASD, Ebstein's anomaly)
- Cardiomyopathy
- Constrictive pericarditis
- Hypertensive heart disease
- Cor pulmonale

ECG features

1. P waves are absent, instead fibrillatory (f) waves with varying morphology (400 or more per minute) are present (Fig. 10.48).
2. QRS complexes occur at a grossly irregular rate (100–160/minute). Irregularly irregular rhythm.

Junctional (nodal rhythm)

In some cases, the pacemaker may change from the SA node to AV node resulting in nodal or junctional rhythm. The P wave is inverted and it may just

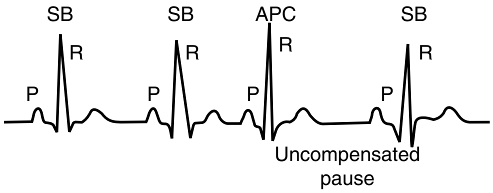


Figure 10.46 Atrial premature complexes. Short PR interval followed by uncompensated pause.

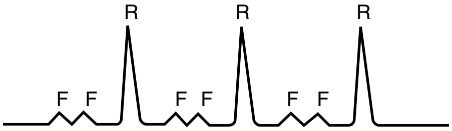


Figure 10.47 Atrial flutter. Two flutter (F) waves followed by single R wave – Ventricular rate regular.

precede or merge with or follow QRS complex. QRS morphology is normal and the heart rate is 60–70 beats/minute (Fig. 10.49).

Junctional premature complexes

These occur due to premature discharge of an ectopic focus located within the AV node (Fig. 10.50).

ECG features

- P waves – Since the atria are activated retrogradely by the junctional beat, the P wave is inverted, and it may just precede or merge with or follow the QRS complex.
- QRS complex morphology is same as that of the sinus impulse.

Junctional tachycardia (idionodal tachycardia)

It is an ectopic junctional rhythm with retrograde P waves caused by enhanced automaticity of a pacemaker located in the AV junction.

Ventricular arrhythmias

Ventricular premature beats or ventricular premature complexes

Ventricular premature beats (VPBs) are complexes that arise due to premature discharge of an ectopic focus located in the ventricular myocardium.

ECG Features

Ventricular premature complex (VPC; VPB) comes earlier than the next anticipated SB, hence premature. It has wide QRS complex as it travels through myocardium and not the specialized conduction tissues. Ventricular premature complexes may be unifocal (all having similar configuration) or multifocal when they arise from different foci and therefore vary in morphology. Following VPC, there is a pause called *compensatory pause* (Fig. 10.51).

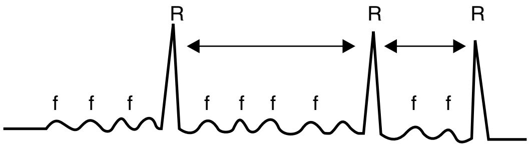


Figure 10.48 Atrial fibrillation. Fibrillatory (f) waves with varying ventricular response (varying RR interval).

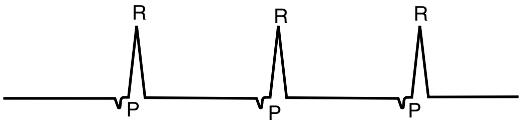


Figure 10.49 Junctional (nodal) rhythm.

Ventricular tachycardia

A series of three or more consecutive ventricular ectopic beats appearing in quick succession constitutes ventricular tachycardia (Fig. 10.52).

Causes of ventricular arrhythmias

- Acute myocardial infarction
- Myocarditis or cardiomyopathy (dilated, hypertrophic)
- Ventricular aneurysm
- End-stage CCF, 2° to rheumatic, hypertensive or congenital heart disease
- Digitalis, adrenergic drugs, quinidine
- Hypoxia, acidosis
- Hypokalemia, hypercalcemia
- Cardiac surgery, cardiac catheterization
- Prolonged QT interval

Ventricular tachycardia may be sustained or nonsustained, and the rate may vary from 120 to

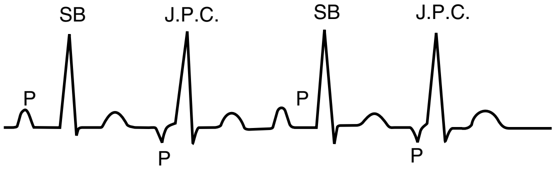


Figure 10.50 Junctional premature complexes. Inverted P waves but QRS morphology same as sinus beat.

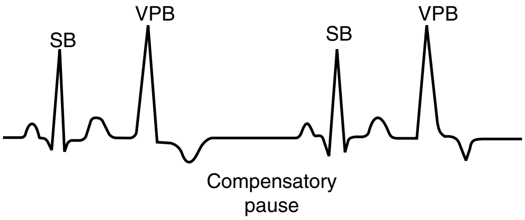


Figure 10.51 Ventricular premature beats followed by compensatory pause (bigeminy).

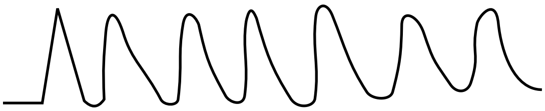


Figure 10.52 Ventricular tachycardia. Wide QRS complexes at regular intervals.

160/minute. Nonsustained tachycardia terminates spontaneously within 30 seconds while sustained ventricular tachycardia lasts longer.

Ventricular fibrillation

It is characterized by chaotic and irregular ventricular complexes without any recognizable wave pattern. It is a common terminal event before death (Fig. 10.53).

Drugs and ECG

Digitalis effect

- ST–T changes (hockey stick pattern) in leads I and V4–V6
- Shortened QT interval
- Prominent U waves
- Bradycardia or various types of blocks (SA and AV blocks Wenckebach's most characteristic)

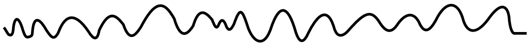


Figure 10.53 Ventricular fibrillation. Wide, chaotic and irregular complexes.

Digitalis toxicity

- ST–T changes in almost all leads (Fig. 10.54)
- Straight downward slope with a terminal rise to the baseline (hockey stick or inverted correction mark sign)
- A rounded, concave or scooped appearance
- Tachyarrhythmias – Commonly seen as unifocal or multifocal VPBs

Quinidine toxicity

- ST segment depression (Fig. 10.55)
- T wave flattening, inversion or widening
- Prominent U waves
- Short PR interval
- Wide QRS complex
- Prolonged QT interval
- Ventricular premature beats, ventricular tachycardia, ventricular fibrillation

Electrolyte disturbances

Hyperkalemia

Effects on ECG would depend upon serum K^+ levels (Fig. 10.56).

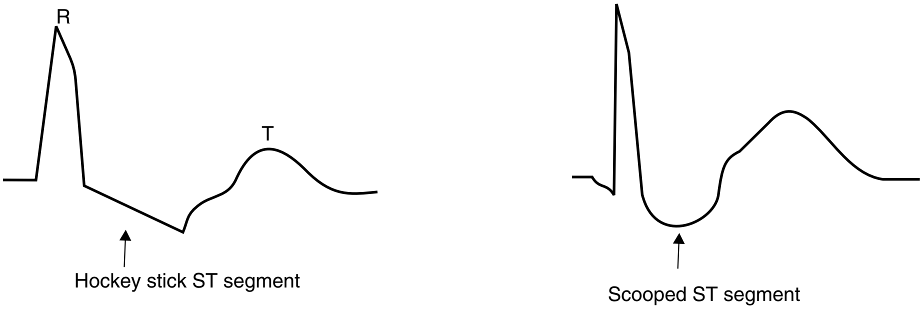


Figure 10.54 Digitalis effect/toxicity.

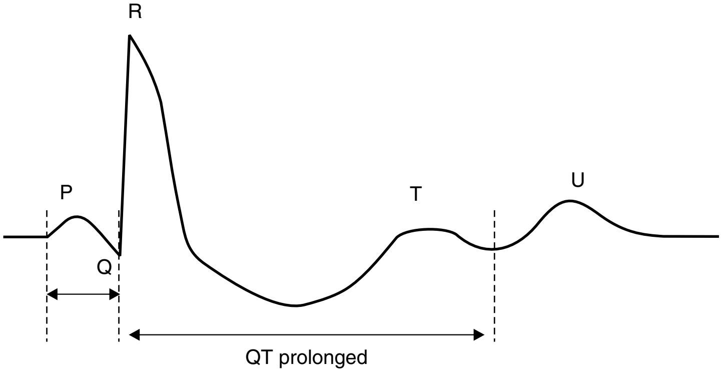
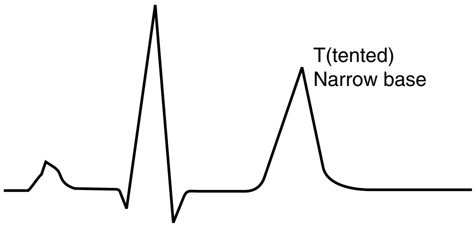
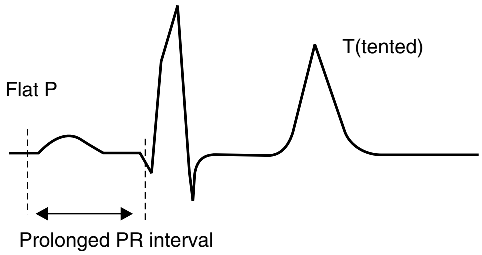


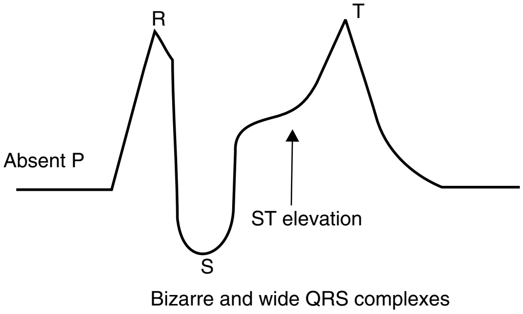
Figure 10.55 Quinidine toxicity. Short PR, widened QRS, prolonged QT, flattened T and prominent U waves.



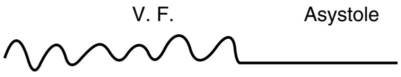
S. K^+ > 6.8 mEq/L



S. K^+ > 8.4 mEq/L



S. K^+ > 9.1 mEq/L



S. K^+ > 12 mEq/L

Figure 10.56 Hyperkalemia.

Serum K^+ greater than or equal to 6.8 mEq/liter

- Tall peaked symmetrical and slender T waves termed as *tented T* waves are the first evidence of hyperkalemia on ECG. These are best seen in precordial leads.
- Shortened QT_c interval.

Serum K^+ greater than 8.4 mEq/liter

- Flat or absent P waves.
- Prolonged PR interval.

Serum K^+ greater than 9.1 mEq/liter

- Widened QRS complex (greater than 0.12 seconds). QRS complex is slurred and bizarre.
- ST segment elevation.
- Sinoatrial and AV nodal blocks may occur with high K levels.

Serum K^+ greater than 12 mEq/liter

- At very high K levels (greater than 12 mEq/liter), ventricular fibrillation or asystole may occur.

Hypokalemia

In hypokalemia, there is no correlation between its severity and ECG changes.

- Low flat T waves – The T waves are reduced in amplitude, flattened or inverted.
- Exaggerated U waves – The U wave is either taller or equal to the T wave and is known as the *camel hump* effect (Fig. 10.57).
- ST segment depression.
- Pseudoprolongation of the QT interval. QT interval is normal and constant, but the QU interval appears prolonged ('U' is mistaken for 'T' wave).
- PR interval is prolonged.
- Hypokalemia may cause bradyarrhythmias, such as the SA block or ventricular arrhythmia, particularly in conjunction with digitalis.
- It may even cause cardiac arrest.

Calcium

Hypercalcemia

Serum calcium levels greater than 12 mg/dl produce a shortening of QT interval (Fig. 10.58).

Hypocalcemia

It prolongs the QT interval; the ST segment is horizontal (Fig. 10.59).

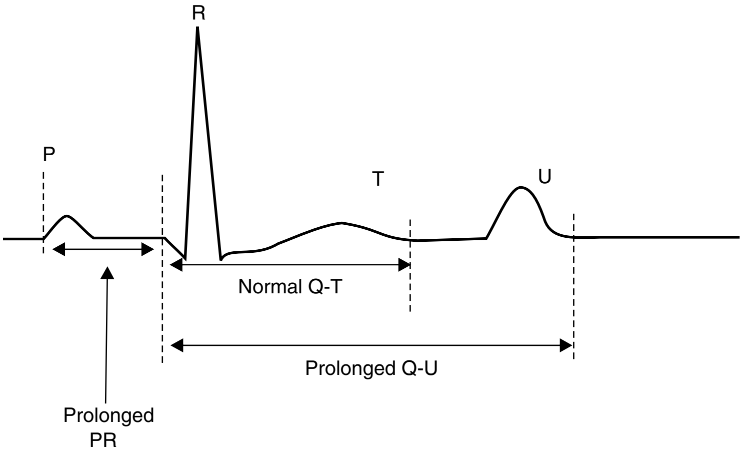


Figure 10.57 Hypokalemia. Low flat T waves (QT interval normal). Exaggerated U wave (QU interval prolonged).

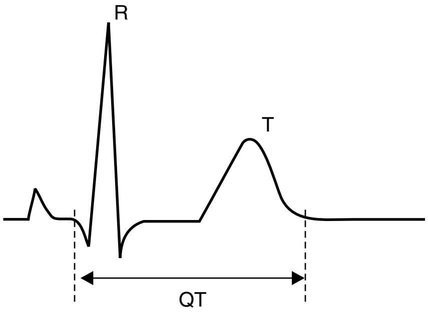


Figure 10.58 Hypercalcemia – Shortening of QT interval.

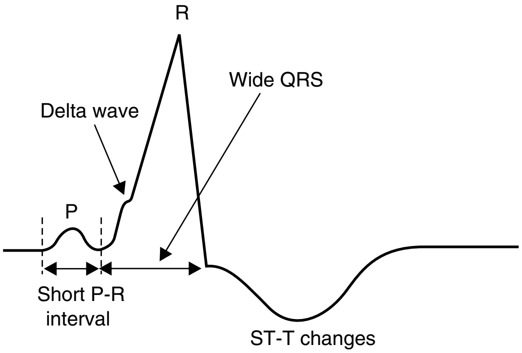


Figure 10.60 WPW syndrome.

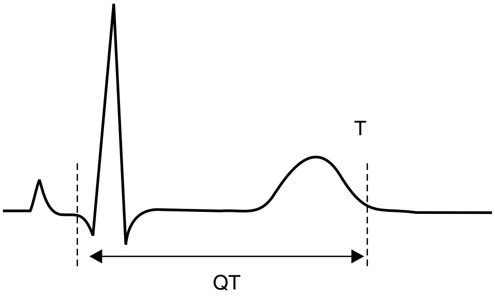


Figure 10.59 Hypocalcemia – Prolonged QT interval and horizontal ST segment.

WPW syndrome

Wolff-Parkinson-White syndrome results from concomitant normal and anomalous conductions of atrial impulses to the ventricles. It is also called *preexcitation syndrome* since ventricles are excited prematurely due to anomalous pathway. The bypass tract is called *bundle of Kent.*

Causes

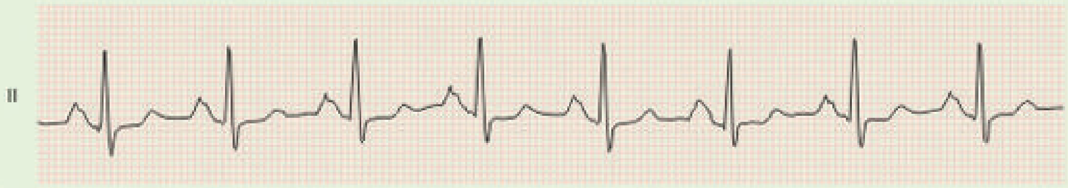
- Mitral valve prolapse
- Hypertrophic obstructive cardiomyopathy (HOCM)
- Ebstein's anomaly (commonest cause)

ECG features

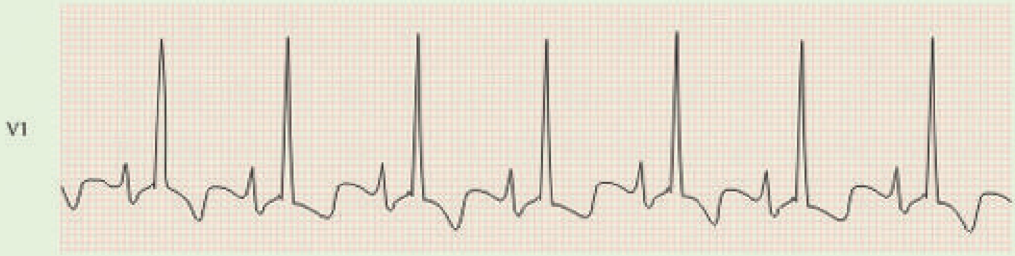
- Short PR interval – Because accessory pathway bypasses the normal AV node and results in premature ventricular depolarization (Fig. 10.60)
- Delta wave
- Wide greater than 0.12 seconds QRS complex (fusion complex due to normal and accessory ventricular activation)
- ST–T changes – Secondary ST segment depression and T wave inversion

ECGs for practice

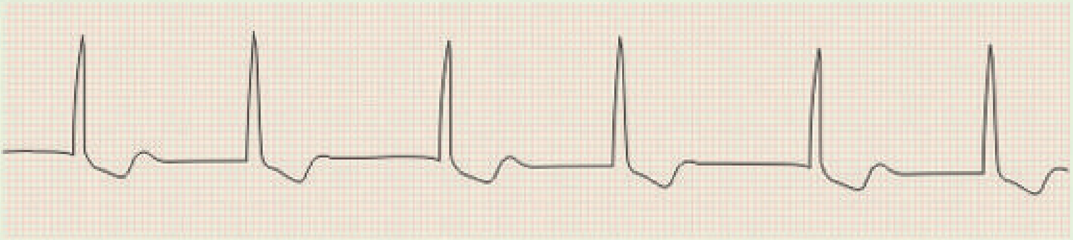
ECG 1



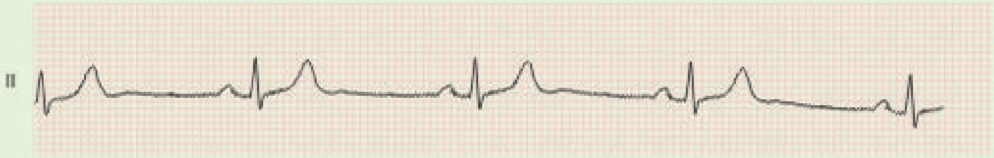
ECG 2



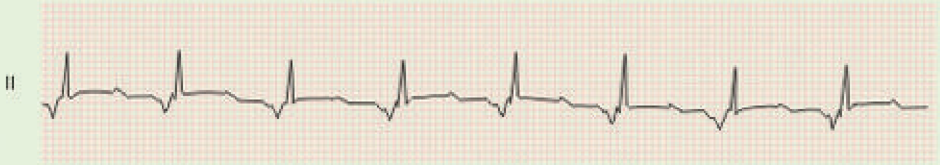
ECG 3



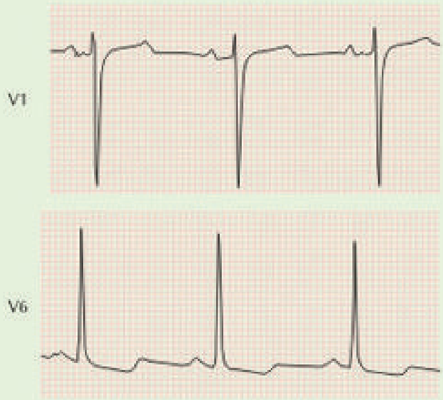
ECG 4



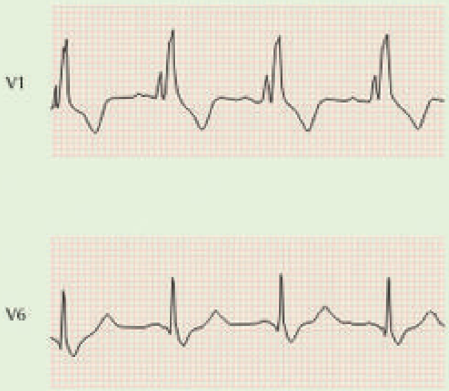
ECG 5



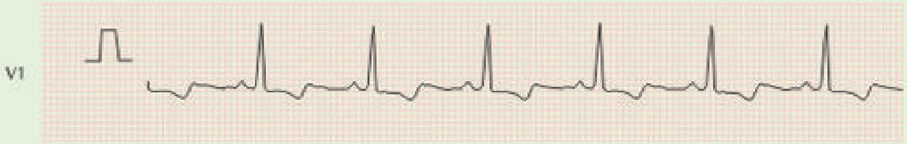
ECG 6



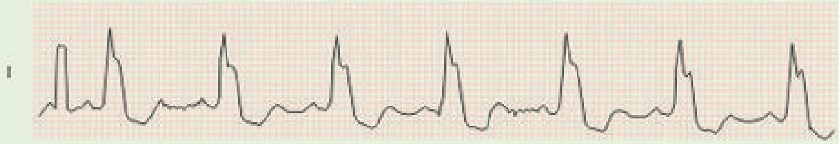
ECG 9



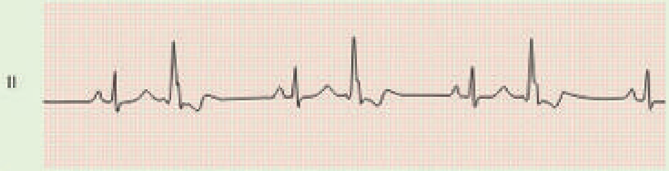
ECG 7



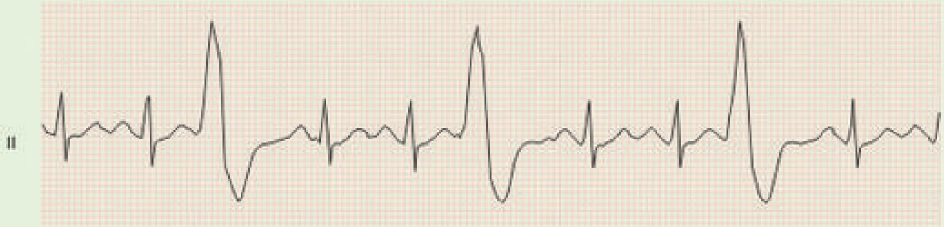
ECG 8



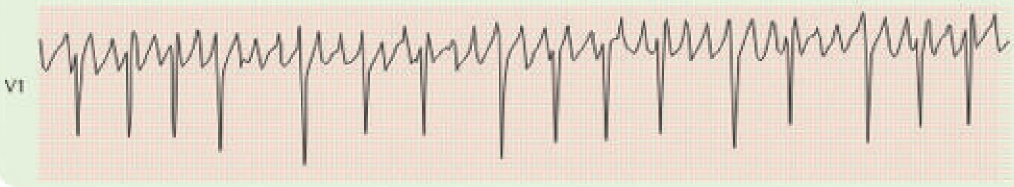
ECG 10



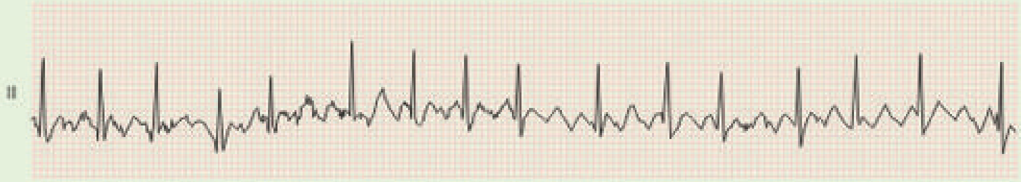
ECG 11



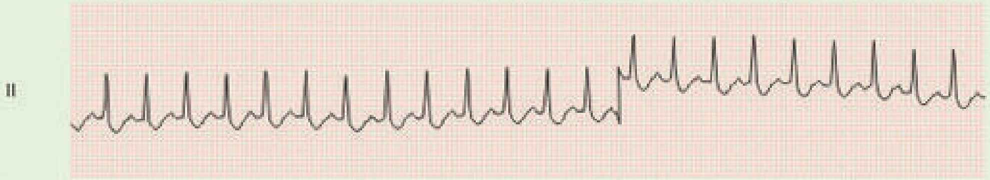
ECG 12



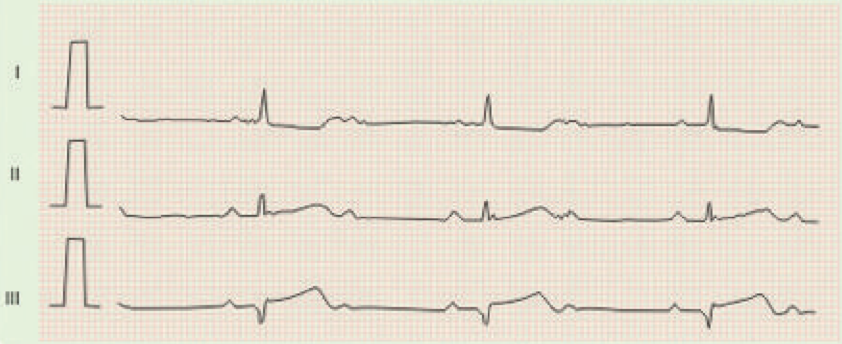
ECG 13



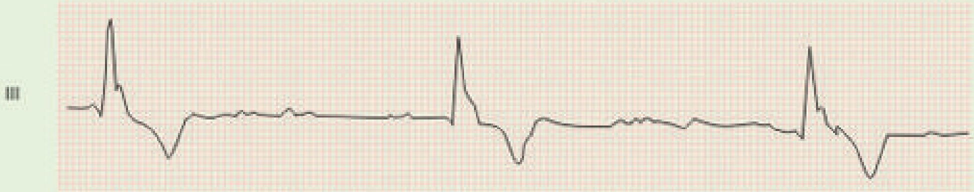
ECG 14



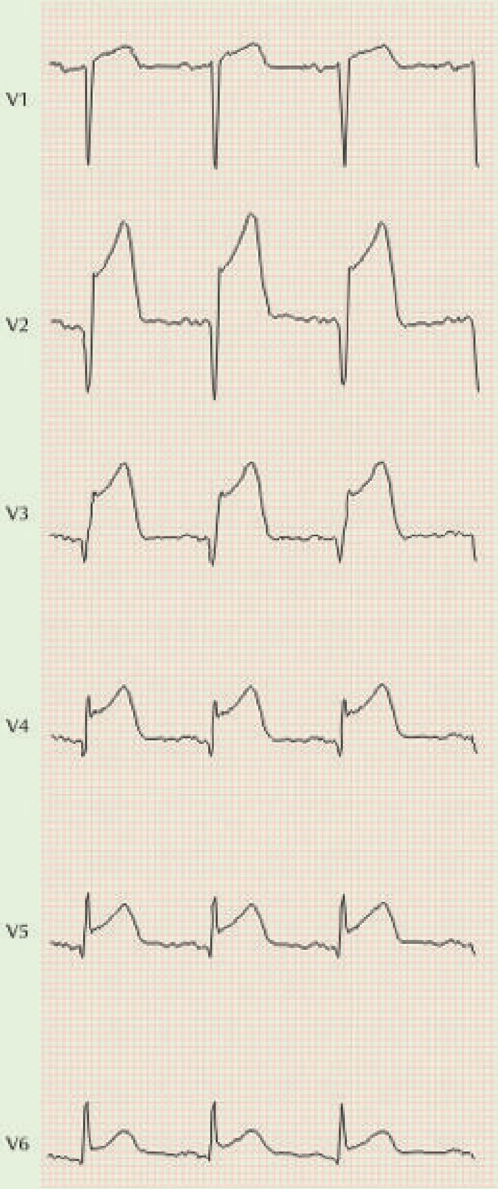
ECG 15



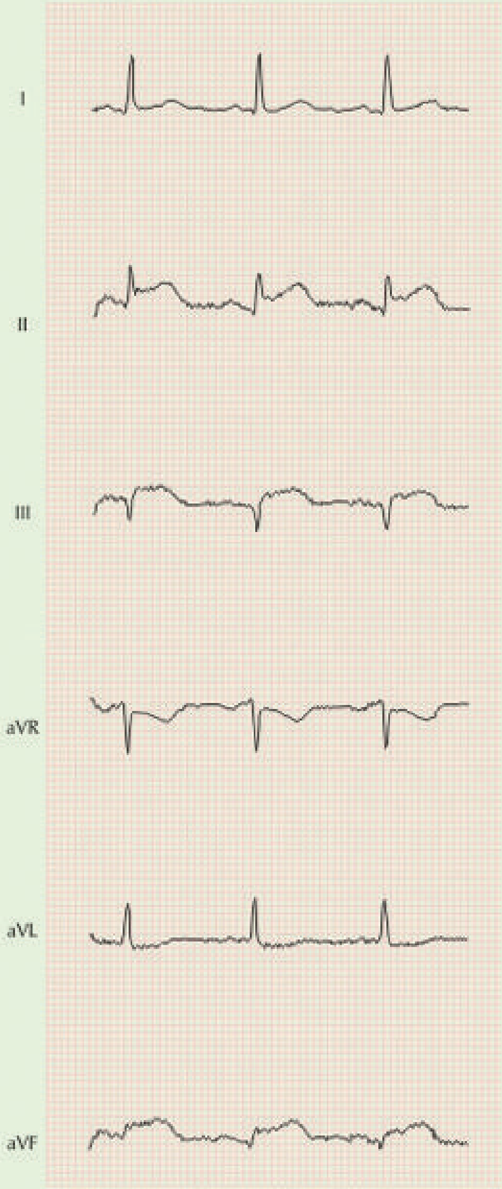
ECG 16



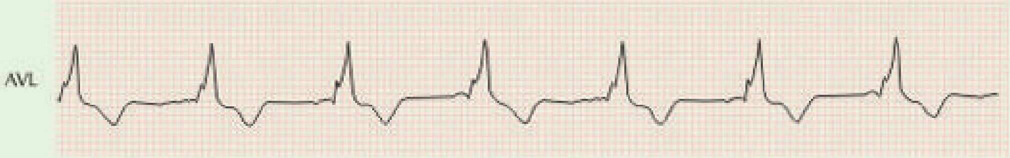
ECG 17


V1
V2
V3
V4
V5
V6

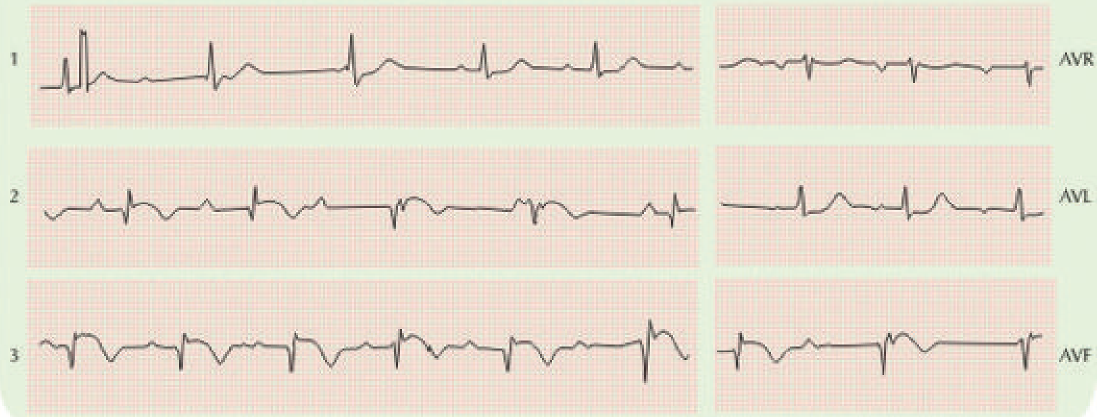
ECG 19


I
II
III
aVR
aVL
aVF

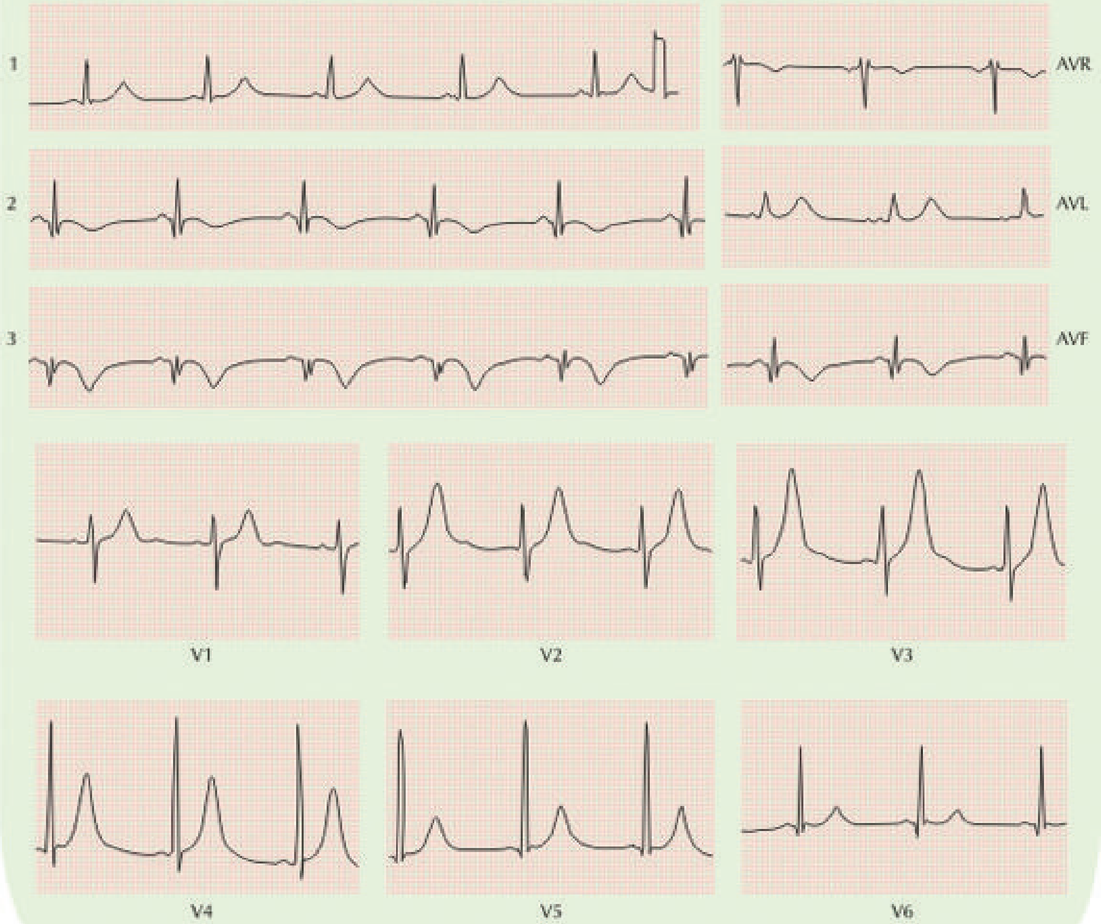
ECG 23



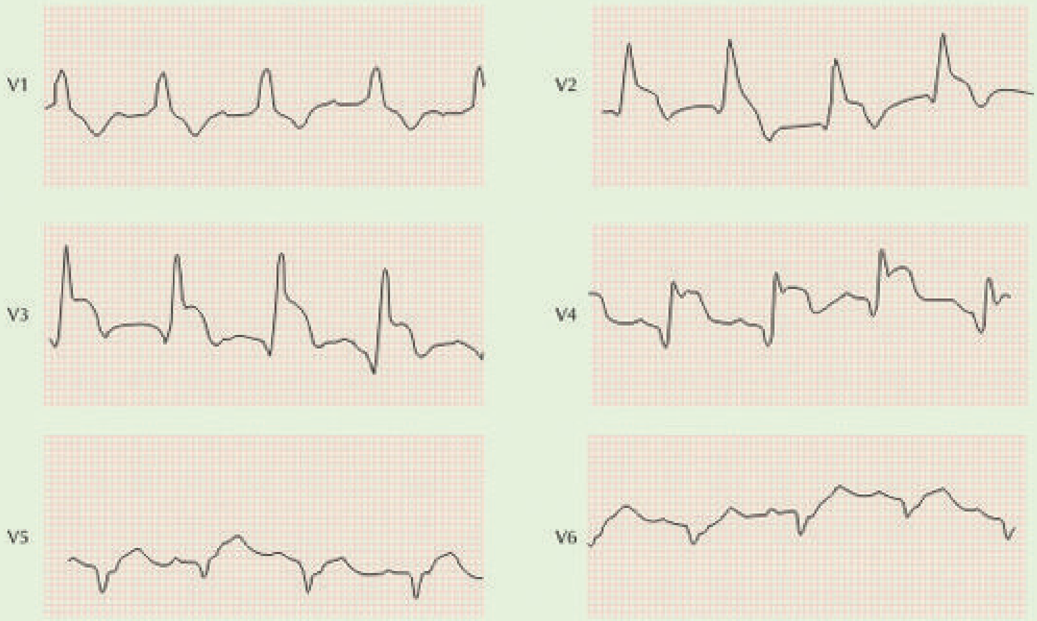
ECG 20


1
AVR
2
AVL
3
AVF

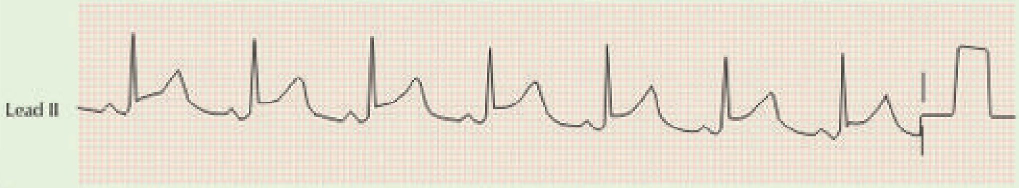
ECG 21


1
AVR
2
AVL
3
AVF
V1
V2
V3
V4
V5
V6

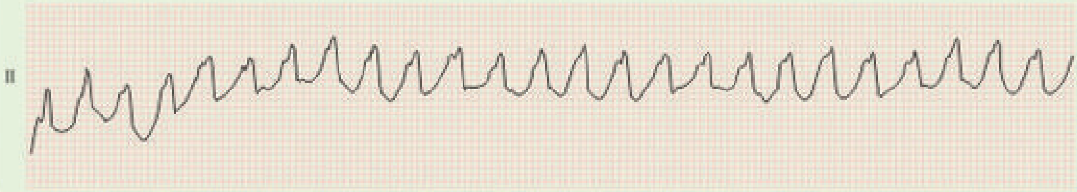
ECG 18


V1
V2
V3
V4
V5
V6

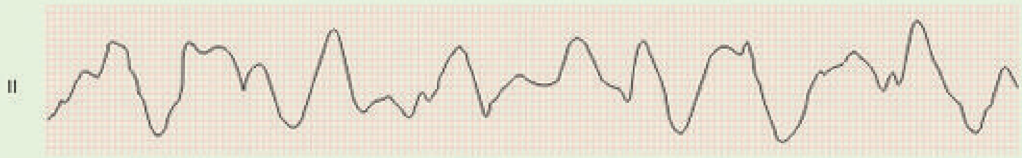
ECG 22



ECG 24



ECG 25



Answers to ECGs

1. **P mitrale** – Note wide notched P wave of greater than 0.10 seconds in duration.
2. **Biatrial hypertrophy with RVH with strain** – Biphasic P wave in V1, initial peaked P wave (P pulmonale) followed by negative deflection (P mitrale) and tall R wave with T wave inversion seen in V1 (RVH with strain).
3. **Digitalis effect (hockey stick T wave)** – The ST segment with T wave appears like the mirror image of the correction mark.
4. **Sinus bradycardia** – Rate less than 50/minute; otherwise normal P-QRST
5. **Idiojunctional (nodal) rhythm** – Note P is inverted and PR interval is short; QRS complex is normal (like sinus beat).
6. **Left ventricular hypertrophy with strain** – The sum of S in V1 and R in V6 is greater than 35 mm (LVH by voltage criteria) with ST–T depression in V6, suggesting strain.
7. **Right ventricular hypertrophy with strain** – In lead V1, tall R is greater than 5 mm along with ST–T depression, which indicates RVH with strain.
8. **Left bundle branch block** – Note wide and notched R waves in lead I.
9. **Right bundle branch block** – Note wide rSR^1 pattern in V1 and slurred S waves in V6.
10. **Bigeminy** – Note SB and VPB followed by compensatory pause (pulsus bigeminus) coming in cycles.
11. **Trigeminy** – Note VPBs coming after every two SBs giving pulsus trigeminus rhythm.
12. **Atrial flutter (2:1, 3:1) block** – Note sawtooth appearance of two or three flutter (F) waves followed by QRS complex.
13. **Flutter fibrillation with fast ventricular response** – Note flutter fibrillatory waves followed by fast QRS complexes coming at irregular interval.
14. **Paroxysmal atrial tachycardia** – Note fast regular (greater than 160/minute) atrial tachycardia.
15. **2:1 AV block** – Note slow regular ventricular rate (less than 50/pm) preceded by two P waves with constant PR interval in every cycle confirming 2:1 AV block.
16. **Complete heart block** – Note very slow (less than 30/minute), regular ventricular heart rate (idioventricular rhythm) with AV dissociation.
17. **Acute anterior wall MI** – Note Q waves and ST elevation in leads V2, V3, V4, V5 (hyperacute phase of AMI) and also a small Q wave in lead V6 with ST elevation.
18. **Right bundle branch block with anterior wall MI** – Wide R waves in lead V1 (RBBB); note coved up ST segment elevation in leads V2, V3 and V4; Q waves in leads V2–V6 suggestive of anterior wall MI.
19. **Acute inferior wall MI** – Note Q waves and coved up ST segment elevation in leads II, III and aVF suggestive of acute inferior wall MI.
20. **Inferior wall MI in evolution** – Note Q waves, elevated ST with coving downwards and T wave inversion in leads II, III and aVF; opposite changes (ST depression) in leads I and aVL.
21. **Inferior wall infarction with true posterior wall MI** – Note Q waves, coved up ST segment elevation and T wave inversion in leads II, III and aVF (inferior wall MI). Also note tall R waves and peaked tall T wave in leads V1, V2, V3 and V4, diagnostic of true posterior wall MI.
22. **Acute pericarditis** – Note ST elevation with concavity upwards, suggestive of acute pericarditis.
23. **Wolff-Parkinson-White syndrome** – Note a very tiny P wave with very short PR interval, delta wave and wide QRS complex with ST depression and T wave inversion, diagnostic of WPW syndrome.
24. **Ventricular tachycardia** – Note wide notched QRS complexes at fast and regular intervals.
25. **Ventricular fibrillation** – Note chaotic irregular ventricular complexes without any recognizable wave pattern.

Chapter 11

Imaging

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INTRODUCTION

Imaging has become an integral part of clinical medicine. A variety of imaging methods are now available, such as

- Screening
- Conventional and digital radiology (most commonly used modality)
- Contrast studies
- Tomography
- Ultrasound (US)
- Computed tomography (CT) scan
- Magnetic resonance imaging (MRI)
- Positron emission tomography (PET) scan

Many factors decide the choice, the most important factor being the nature of the clinical problem and its urgency. In our set-ups, cost considerations are important.

RESPIRATORY SYSTEM

Chest X-ray

This is the first imaging modality ordered in respiratory disorders. A chest X-ray visualizes

- Heart
- Lung parenchyma, pulmonary vessels
- Trachea, bronchial tree
- Pleura
- Mediastinum
- Hilum
- Diaphragm
- Chest wall (thoracic cage, soft tissues)
- Root of neck

The standard X-ray view is a posteroanterior (PA) view of chest (X-rays passing postero-anteriorly [i.e. from back to front] with the patient's chest against an X-ray cassette). Digital X-rays provide a better definition of structures. Advantages of PA view of chest are (1) minimal magnification of cardiac shadow, (2) more accurate assessment of the mediastinum including the heart and (3) better assessment of pulmonary vasculature and pleural thickening.

A chest X-ray is 'read' as follows

- Note printed details (e.g. name, date of birth and sides [right and left])
- X-ray projection (PA or antero posterior [AP])
- Exposure (adequate, under or overexposed)
- Centralized or rotated
- In full inspiration or in expiration
- Thoracic cage (vertebrae, ribs, clavicles)
- Soft tissue and breast shadows
- Diaphragm
- Costophrenic and cardiophrenic angles
- Mediastinum
- Lungs, pulmonary vasculature, trachea, proximal bronchi
- Root of neck

Normal chest X-ray (Fig. 11.1)

- It is well centralized (both clavicles are at the same level with medial ends of both the clavicles equidistant from vertebral spinous processes and overlying transverse processes of 4th or 5th thoracic vertebra).
- With adequate exposure, upper four thoracic vertebrae are visualized.
- In females, breast shadows are seen. Sometimes, nipple shadows can be identified. Breast shadows often partially obscure lung bases.
- Ribs slant down posteroanteriorly. Costal cartilage calcification (often present) has no diagnostic significance. The pattern of calcification varies between males and females.
- Right diaphragm is one intercostal space higher (3–4 cm) than the left diaphragm. A difference greater than this, in a conventional X-ray, is abnormal.
- In a full inspiratory film, anterior ends of 5th ribs and posterior ends of 10th ribs are clearly visible.
- Costophrenic and cardiophrenic angles are clear.
- Mediastinum is central. The upper trachea is central with slight displacement to right and inferiorly of lower part of trachea. Heart borders are clearly seen, except the diaphragmatic border.
- Interlobar fissures may be visible (greater and lesser fissures are better seen in lateral films).
- Left hilum is 0.5–2.0 cm higher than the right hilum. Both hila have concave borders and equal density.
- Fundic air is seen below the left diaphragm.

Other X-ray views

- Lateral – For right and left lung pathologies, right and left lateral views are taken (Fig. 11.2; for position of fissures and segments, Fig. 4.6)
- Oblique
- Lordotic – To visualize apex of lung
- Lateral decubitus – To visualize minimal pleural effusion (Figs. 4.11, 4.17)
- End expiratory to detect pneumothorax, especially small pneumothorax. Routinely X-ray is taken with the breath held in full inspiration
- Antero posterior – Opposite of PA. Usually used in an acutely ill patient who cannot sit. Main disadvantage is that cardiac size cannot be assessed

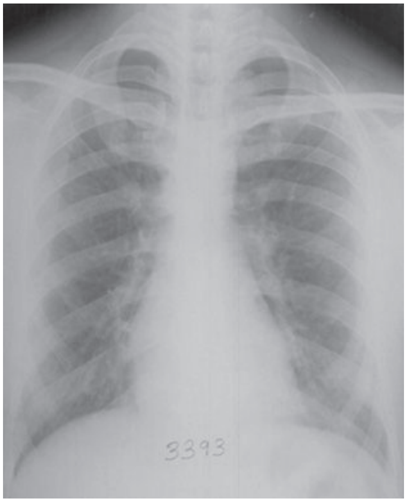

Figure 11.1 Normal chest X-ray, posteroanterior view.

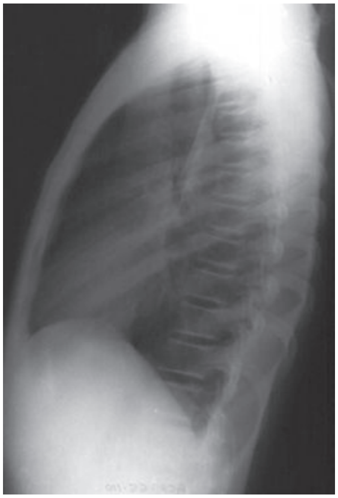

Figure 11.2 Normal lateral chest X-ray.

Abnormal X-rays

Thorax

Abnormalities can be developmental or acquired.

Developmental abnormalities

- Hemivertebra, spina bifida
- Scoliosis
- Kyphosis
- Cervical rib
- Bifid rib

Acquired abnormalities

- Vertebral pathologies (e.g. fracture, infection, secondaries)
- Paravertebral pathologies (e.g. abscess, tumor)
- Resected rib
- Scoliosis
- Tumor of rib (Fig. 11.45)

Pulmonary abnormalities

Opacities
- Alveolar shadows
- Nodular, reticulonodular shadows
- Miliary shadows
- Calcification

Translucencies
- Cavity, cyst, abscess
- Emphysema

Pulmonary opacities

Pulmonary opacities are broadly classified as alveolar or interstitial. The former are due to filling of pulmonary acini with fluid, fat, blood or cells. Acinar (alveolar) shadows are approximately 7 mm in size, ill-defined, nonsegmental and may coalesce to form larger shadows (homogenous or patchy). Characteristically, air bronchogram is present (Fig. 11.3).

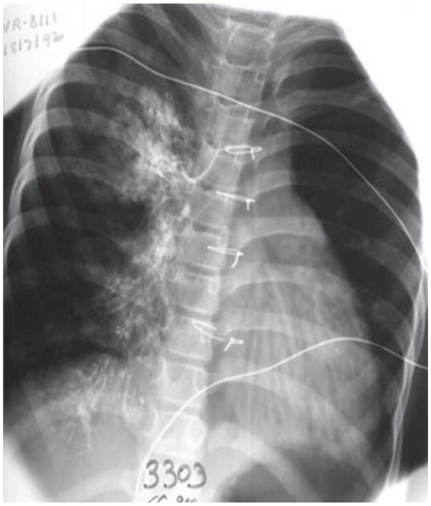

Figure 11.3 Air bronchogram.

Interstitial shadows are due to thickening of the interstitium (perivascular tissues). Radiologically, these produce reticular, nodular or reticulonodular opacities or ground glass appearance. There may be honeycombing. Nodular shadows may be miliary (less than 2 mm; Fig. 11.4A) or larger (2–5 mm). Their density can vary from soft to calcific.

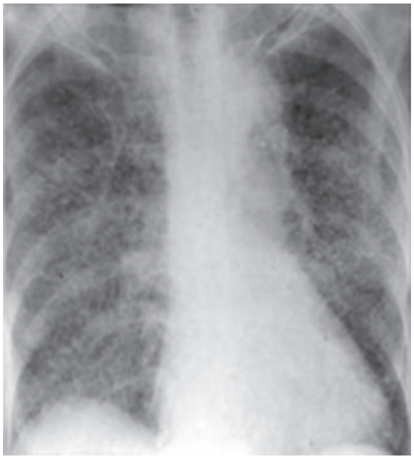

Figure 11.4A Miliary mottling.

Causes of miliary shadows

- Miliary tuberculosis (Fig. 4.34)
- Tropical eosinophilia
- Metastasis
- Lymphangitis carcinomatosis, leukemia, lymphoma
- Sarcoidosis
- Pneumoconiosis
- Histoplasmosis and other fungal diseases
- Acute extrinsic allergic alveolitis
- Fibrosing alveolitis
- Alveolar microlithiasis
- Hemosiderosis
- Hyaline membrane disease
- Calcified miliary shadows (e.g. TB, postchicken pox)

Causes of nodular shadow(s)

These can be single or multiple.
- Granuloma (TB, histoplasmosis; single or multiple)
- Carcinoma lung (solitary lesion)

- Metastasis (breast, thyroid, GIS, kidney, testes; single or multiple)
- Benign tumor(s)
- Pulmonary infarction (single or multiple)
- Sarcoidosis (multiple)
- Rheumatoid nodule (single or multiple; Fig. 11.4B)
- Rheumatoid arthritis with pneumoconiosis (Caplan's syndrome)
- Wegener's granulomatosis (single or multiple)
- Extrinsic allergic alveolitis (multiple)
- Drug reaction (multiple)
- Pneumoconiosis (multiple)
- Hemosiderosis (multiple)
- Fat embolism (multiple)
- Hydatid cyst (single or multiple)
- Pulmonary arteriovenous malformation (single or multiple)

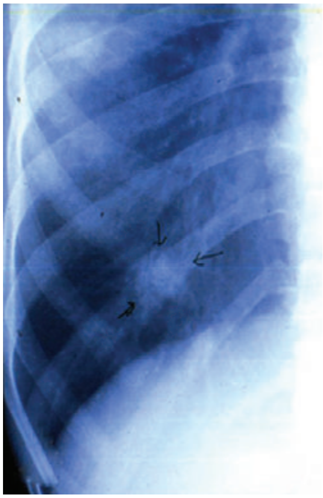

Figure 11.4B Rheumatoid nodule of the lung.

Causes of diffuse interstitial shadows

- Infection – Bacterial (TB), viral, fungal, parasitic, protozoal (*Pneumocystis jiroveci*)
- Cardiac – Pulmonary venous congestion (early left ventricular failure), pulmonary venous occlusion
- Malignancy – Lymphoma, leukemia, lymphangitis carcinomatosis, alveolar cell carcinoma
- Rheumatic diseases – Systemic sclerosis, rheumatoid arthritis, systemic lupus erythematosus, mixed connective tissue disease, Sjögren's syndrome, vasculitis
- Drugs – Busulfan, methotrexate, bleomycin
- Others – Bronchiectasis, interstitial lung disease, sarcoidosis, extrinsic allergic alveolitis, histiocytosis X
- Environmental pulmonary diseases (inorganic and organic dusts)

Causes of diffuse, poorly defined alveolar opacities

- Pulmonary edema (Fig. 3.30)
- Acute respiratory distress syndrome
- Infection (e.g. viral, Gram-negative organisms)
- Pulmonary hemorrhage
- Alveolar cell carcinoma

Causes of honeycomb shadows*

- Systemic sclerosis, rheumatoid arthritis
- Idiopathic interstitial pulmonary fibrosis
- Sarcoidosis
- Pneumoconiosis
- Histiocytosis X

Note – Honeycomb shadows are best visualized on high-resolution CT (HRCT) of chest.

Causes of solitary pulmonary nodule (1–6 cm in diameter)

- Tumor
  - Malignant (primary or secondary)
  - Benign
- Granuloma (TB, parasitic, fungal, lupoid)
- Infection (abscess, pneumonia, hydatid cyst)
- Pulmonary infarct
- Rheumatoid arthritis, Wegener's granulomatosis
- Sequestrated lung
- Pleural
  - Loculated effusion
  - Tumor (primary, secondary)

Causes of Cavity

- Cavity is a defined area of radiolucency. To diagnose a cavity, two-thirds of its wall must be clearly made out.

Causes

- Infection – Tuberculosis (Figs. 4.32 and 4.33), staphylococcal, Klebsiella, fungal and hydatid cyst
  - Lung abscess (Figs. 4.30 and 11.8)

- Tumor (primary and secondary)
- Lymphoma
- Cystic lung disease, cystic bronchiectasis (Fig. 4.27), bronchogenic cyst
- Bulla (Figs. 4.25, 11.10), pneumatocele
- Silicosis
- Pulmonary sequestration
- Wegener's granulomatosis, rheumatoid nodule (Fig. 11.4B)
- Traumatic

Causes of upper zone infiltrates/cavity

- Tuberculosis
- Fungal infection (Fig. 11.9)
- Nocardia
- Atypical pneumonia
- Ankylosing spondylitis
- Atypical mycobacterial infection
- Actinomycosis
- Silicosis
- Pulmonary infarct

Causes of air-fluid level on chest X-ray

- Lung abscess (Figs. 4.30, 4.31, 11.8)
- Hydropneumothorax (Fig. 4.49)
- Carcinoma esophagus (Fig. 11.29), achalasia cardia (Fig. 11.27)
- Hydropneumopericardium
- Diaphragmatic hernia (Figs. 2.7, 11.28)
- Mediastinitis

Causes of calcification on chest X-ray

Parenchymal

- Granuloma (TB most common)
- Lymph nodes (TB [Fig. 11.5], sarcoidosis)
- Abscess
- Tumor (usually benign)
- Bronchiolitis, alveolar microlithiasis
- Healed tuberculous pleural effusion (Fig. 11.6), empyema and hemothorax
- Asbestosis
- Postchicken pox bronchopneumonia

Hilar calcification

- Tuberculosis
- Sarcoidosis
- Treated lymphoma
- Silicosis

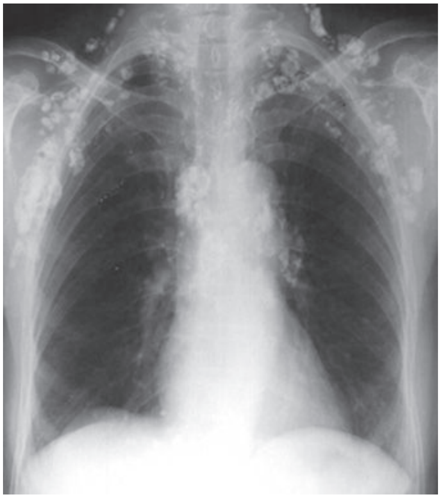

Figure 11.5 Calcified lymph nodes in the neck and axillae.

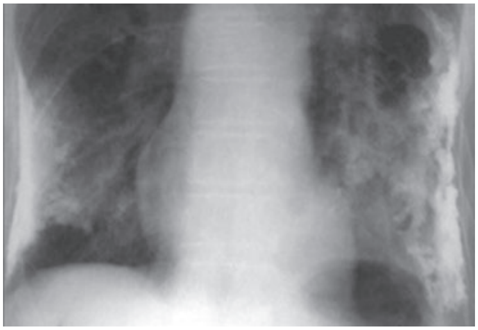

Figure 11.6 Pleural calcification, secondary to old tubercular effusion.

Extrapulmonary calcification

- Dermoid, thymus, thyroid
- Aorta (Figs. 11.20, 11.21)
- Costal cartilage, breast, guinea worm
- Constrictive pericarditis (Fig. 3.51)
- Cervical, axillary lymph nodes (Fig. 11.5)

Causes of hilar enlargement

Unilateral enlargement

- Rotation, scoliosis
- Lymph node(s) (TB, sarcoidosis, secondaries, lymphoma)
- Tumor
- Pulmonary artery aneurysm, pulmonary embolism (PE)
- Pericardial cyst, tumor

Bilateral enlargement

- Expiratory film
- Lymphoma
- Sarcoidosis (Fig. 4.41)
- Tuberculosis
- Pneumoconiosis
- Pulmonary hypertension (PHT; primary and secondary)
- Pulmonary plethora (left-right shunt; Figs. 3.55, 3.56)
- Acquired immune deficiency syndrome
- Lymphangitis carcinomatosis

Causes of displaced hilar shadows

- Fibrosis – Commonly TB of upper lobe with pulled up hilum
- Collapse – Lobar or segmental

Causes of increased translucency hilar shadows

- Rotation, scoliosis (unilateral)
- Compensatory, secondary to collapse, post lobectomy
- Emphysema (Fig. 4.24), bronchial asthma (bilateral)
- Bulla (Figs. 4.25, 11.10)
- Pneumothorax (Figs. 11.18, 11.19)
- Ball-valve endobronchial obstruction
- Pulmonary embolism
- Mastectomy
- Macleod's syndrome
- Fallot's tetralogy (Fig. 5.39), primary PHT, agenesis of pulmonary artery

Causes of uniform lung opacities

- Pleural effusion (Fig. 4.44)
- Consolidation
- Collapse (lobar or whole lung)
- Thickened pleura
- Dense pulmonary fibrosis
- Pneumonectomy, thoracoplasty
- Mesothelioma
- Large pulmonary growth

Causes of raised diaphragm

Unilateral elevation of diaphragm

- Eventration of diaphragm
- Scoliosis
- Subphrenic pathology (abscess, tumor, hepatomegaly)
- Pulmonary infarction
- Phrenic nerve palsy

Bilateral elevation of diaphragm

- Poor inspiratory effort
- Restrictive lung disease
- Abdominal distension

Silhouette sign

It is loss of demarcation between lung shadow and adjacent structures. It helps to identify the affected lobe of the lung.

Site	Lung lobe/segment
Diaphragm*	Lower lobe
Right heart border	Middle lobe
Left heart border	Lingular segment of left lower lobe
Right upper border of mediastinum	Right upper lobe
Left upper border of mediastinum	Left upper lobe

Left upper lobe consolidation produces a veil-like opacity over the left hemithorax.

*Effacement of diaphragmatic shadow can be due to pleural and subdiaphragmatic pathologies.

X-ray appearances of specific pulmonary pathologies

Lobar pneumonia (Fig. 4.56)

- Uniformly dense opacity (less opaque than cardiac shadow) with apex pointing towards hilum and base resting on pleural surface
- A well-defined border if bordered by a fissure
- Air bronchogram (Fig. 11.3)
- No loss of lung volume
- No shift of mediastinum

Endobronchial obstruction

- Carcinoma bronchus
- Benign tumor
- Mucus plug, secretions

- Foreign body
- Malpositioned endotracheal tube

Collapse of whole lung

- Dense opacification of the entire lung (hemithorax)
- Compensatory emphysema of opposite lung
- Marked shift of mediastinum to the same side with herniation of the opposite lung (mediastinal herniation)
- Crowding of ribs, shrunken hemithorax
- Elevated hemidiaphragm
- With persistent obstruction, absent air bronchogram (at the site of obstruction, bronchial shadow ends abruptly)

Persistent collapse with patent bronchus (Fig. 11.7)

- All the above features, except for the presence of air bronchogram and cystic or fusiform bronchiectasis.

Klebsiella pneumonia

- Multiple opacities with cavitation
- Usually involves upper lobes

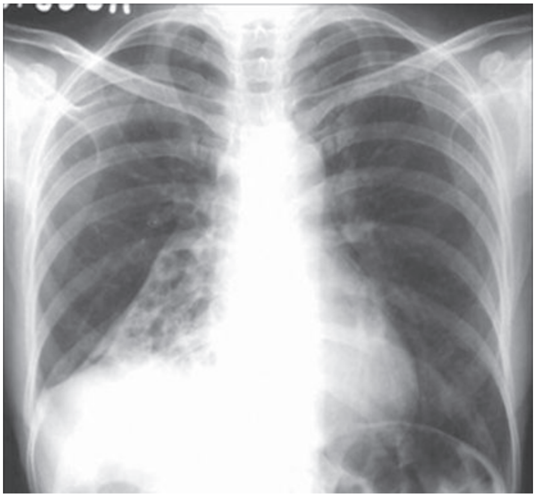

Figure 11.7 Right lower lobe collapse with bronchiectasis and pleural effusion.

Lung abscess (Figs. 4.30, 11.8)

A rounded opacity with
  - ❑ Cavitation
  - ❑ Thick irregular wall
  - ❑ Fluid level

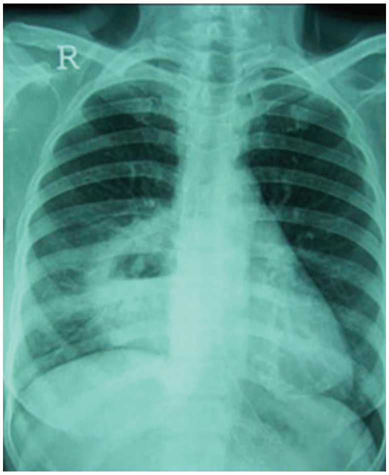

Figure 11.8 Lung abscess.

Bronchiectasis (Figs. 4.26, 4.27)

- Thickened bronchial walls with tram-like shadows
- Cystic or fusiform bronchiectatic shadows
- Shadow of collapsed lobe of lung if bronchiectasis is secondary to collapse (Fig. 11.7)
- X-ray may appear normal except for increased lung markings

High-resolution CT of chest is the investigation of choice to confirm the diagnosis of bronchiectasis. It shows both the extent and the distribution of bronchiectasis (Fig. 4.29). Previously bronchography was the diagnostic procedure (Fig. 4.28).

Fungus ball (mycetoma) (Fig. 11.9)

- Round opacity (fungus ball) within a (healed) cavity with a ring of air shadow around it
- The opacity (fungus ball) shifts with change of posture

Emphysema (Figs. 4.24, 4.25)

- Widening of intercostal spaces with horizontal ribs

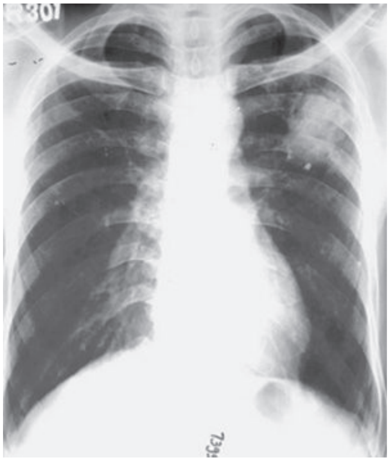

Figure 11.9 Fungus ball left upper lobe.

- Anterior ends of 6th ribs are visible above the diaphragm
- Flattened diaphragms
- Hypertranslucent lung fields
- Large proximal pulmonary arteries
- Decreased peripheral vascular markings
- Bullae (Figs. 11.10, 11.11)
- Lung shadow may be interposed between the inferior border of heart and the diaphragm
- Increased retrosternal air space (seen in lateral view)
- In advanced stage of the disease, main branches of pulmonary artery enlarge due to PHT (right main descending artery greater than 16 mm)

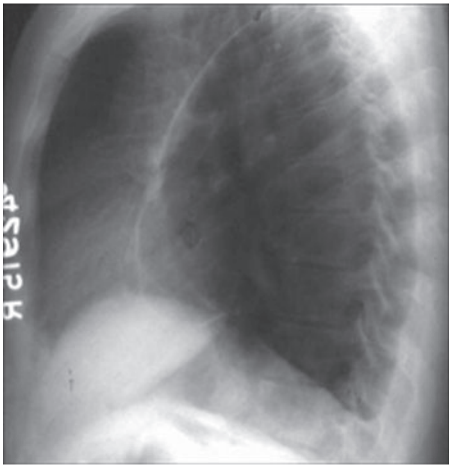

Figure 11.10 Emphysematous bulla (lateral view).

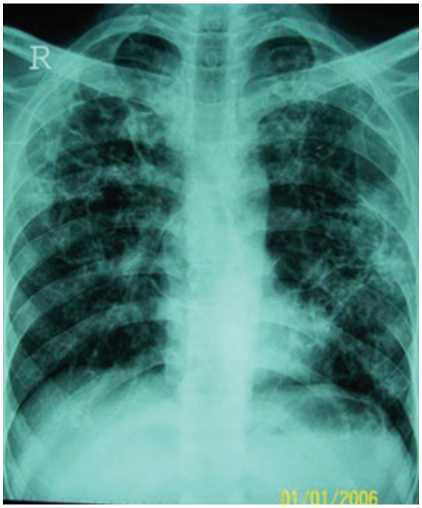

Figure 11.11 Multiple bullae.

X-ray taken during an attack of asthma shows similar changes; except that large pulmonary arteries, bullae and loss of pulmonary markings are not present.

Carcinoma of the lung (Fig. 4.43)

X-ray appearances are variable. There may be
- Solitary lung nodule or a mass with irregular margins (±)
- Hilar and mediastinal lymphadenopathy
- Collapse of distal lung
- Pleural effusion
- Metastasis to the rest of lung and bony cage

Pancoast tumor (Fig. 11.12)

- An apical tumor. Usually non-small cell lung cancer
- Invades brachial plexus, pleura, ribs, sympathetic chain causing
  - ❑ Pain in shoulder and upper extremity
  - ❑ Weakness and wasting of hand
  - ❑ Horner's syndrome
  - ❑ Rarely cardiac tamponade and dysphagia

Extrinsic allergic alveolitis

- Bilateral miliary mottling, particularly in mid zones
- Rarely hilar lymphadenopathy

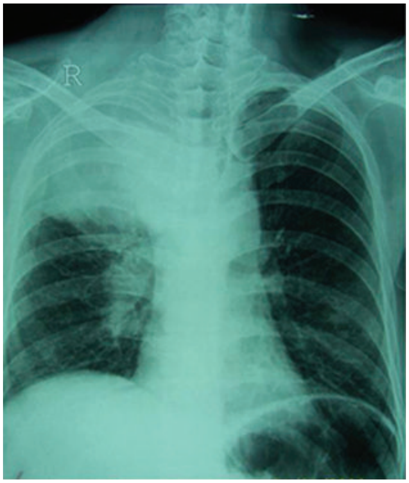

Figure 11.12 Pancoast tumor. Note – Destroyed 1st rib.

Idiopathic pulmonary fibrosis (Figs. 4.53, 4.54, 11.13)

- Decreased lung volume (reduced vertical height)
- Diffuse reticulonodular shadows especially involving the lower zones
- Diffuse or patchy ground glass haziness
- Features of PHT, when present
- Honeycombing (with advanced disease)

High-resolution CT is the investigation of choice to assess alveolitis (seen as ground glass appearance) and the extent of fibrosis. Additionally, HRCT shows thickened interalveolar septa, traction bronchiectasis and honeycombing (Figs. 4.54, 11.14).

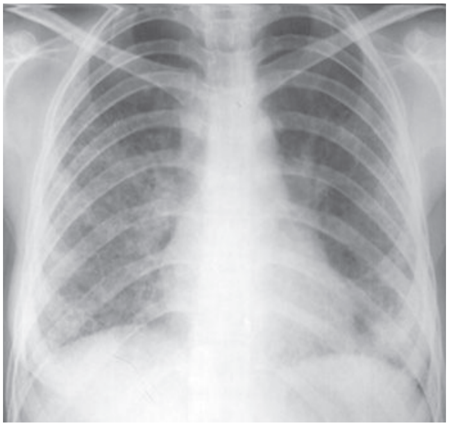

Figure 11.13 Idiopathic pulmonary fibrosis.

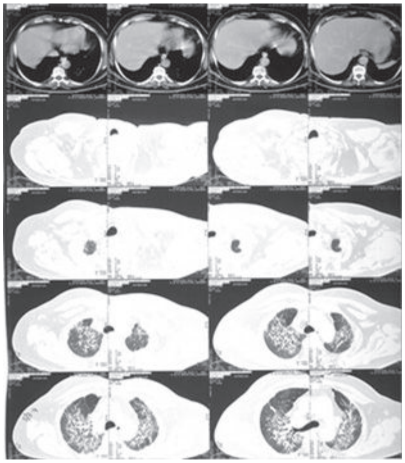

Figure 11.14 HRCT idiopathic pulmonary fibrosis.

Dense pulmonary fibrosis (localised or diffuse)

- Reticulonodular opacification
- Volume loss
- Ill-defined borders

Pneumonectomy

- Dense opacification of the entire hemithorax
- Marked shift of the mediastinum to the same side with compensatory emphysema and herniation of the opposite lung
- Crowding of ribs
- Elevated hemidiaphragm
- Resected rib (usually 5th) with subperiosteal new bone formation may be visible

Pulmonary tuberculosis (TB)

Appearances vary with primary and post primary TB.

Primary TB

- Peripheral small homogenous infiltrates with hilar and paratracheal lymph nodes, typical of primary complex (Ghon's lesion).
- Additional or other findings may be
  - ❑ Pleural effusion
  - ❑ Cavitation with progressive primary TB

Post primary TB (reactivation, adult) TB (Figs. 4.32, 4.33, 4.37)

A variety of X-ray appearances are seen, e.g.

- Apical infiltrates
- Cavity
- Fibrocavitary shadows

- Nodules
- Miliary shadows
- Lower lobe involvement in elderly and in immunocompromised individuals
- Bronchostenosis (stricture) with collapse consolidation

Healed lesions

- Dense hilar nodules with or without calcification
- Upper lobe scarring, fibrosis
- Bronchiectasis

Pulmonary infarction

Chest X-ray findings are usually nonspecific. It may show any of the following features

- Peripherally situated wedge-shaped opacity
- Atelectasis
- Focal infiltrates
- Elevated hemidiaphragm
- Pleural effusion

Sarcoidosis

Depending upon the stage of the disease, X-ray shows

- Bilateral hilar and mediastinal lymphadenopathy (Fig. 4.41)
- Bilateral hilar and mediastinal lymphadenopathy plus reticulonodular pulmonary infiltrates
- Only peripheral pulmonary infiltrates.
- Subpleural nodules
- Pulmonary fibrosis
- Honeycombing
- Pleural effusion

Free pleural effusion (Figs. 4.31, 4.44)

- Homogenous dense opacity (as dense as cardiac shadow), maximally opaque inferiorly and less opaque superiorly
- Obscures diaphragmatic shadow and obliterates costophrenic angle. Just obliteration of costophrenic angle may be due to a small pleural effusion or thickened pleura. Ultrasound examination can distinguish between the two
- Concave medial border (in early stages, medial border is hazy) (a convex medial border suggests loculation; Figs. 11.15A, B)
- The shadow rises higher in the axilla
- Absence of air bronchogram
- Shift of mediastinum to the opposite side with significant effusion
- Fissures may be prominent

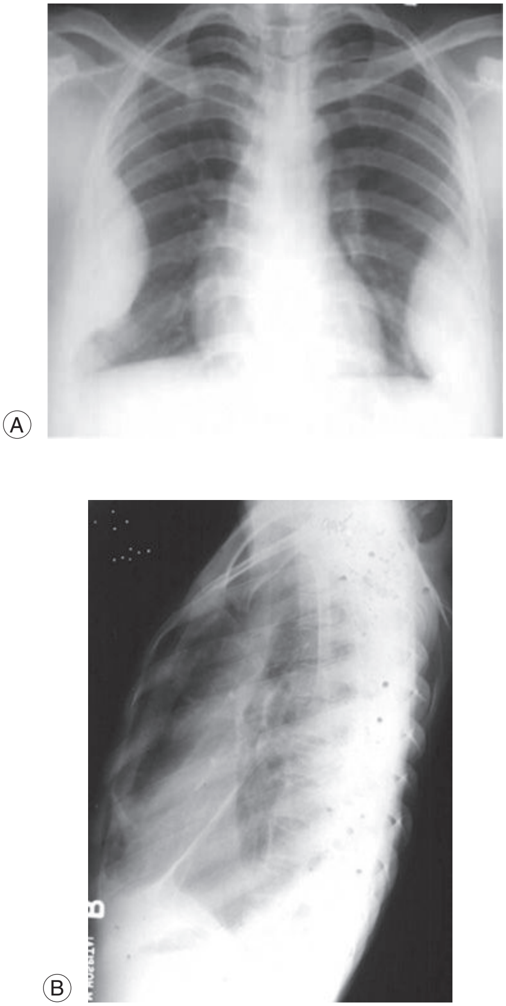

Figure 11.15 (A) Bilateral loculated pleural effusions. (B) Posteriorly loculated pleural effusion (lateral view).

- With pleural fibrosis, shrinkage of hemithorax and shift of the mediastinum to the same side occurs (Fig. 11.16)

Sites of loculation of pleural effusion

- Lateral
- Infrapulmonary*(Fig. 11.17)
- Interlobar
- Apical

*When suspected a lateral decubitus shoot through X-ray is taken. The fluid flows out and opacifies lateral pleural space.

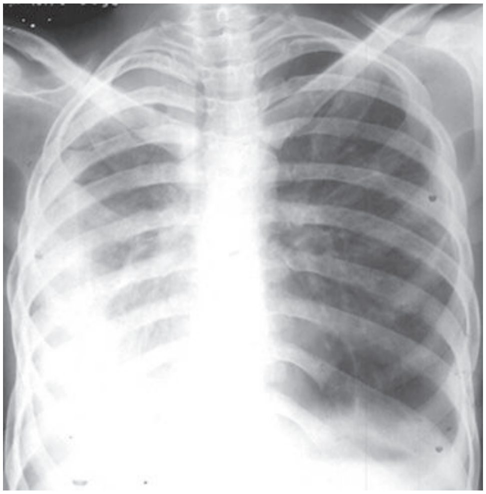

Figure 11.16 Pleural effusion with pleural fibrosis. Note ipsilateral shift of trachea and mediastinum.

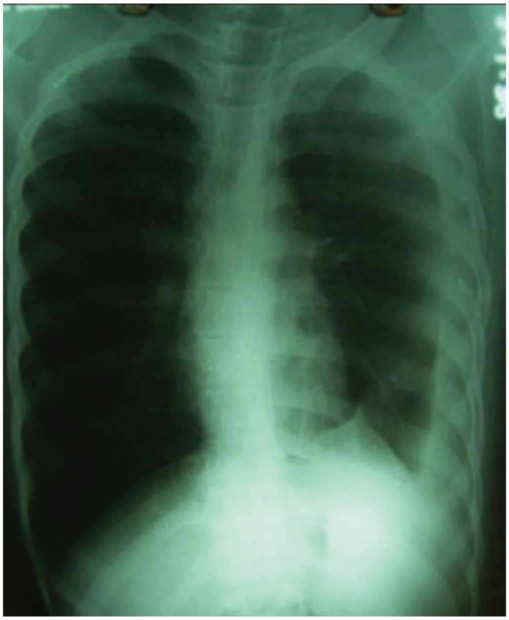

Figure 11.17 Chest X-ray (lateral decubitus view) demonstrating pleural effusion.

- Mediastinal
- Posterior

Pneumothorax (Figs. 4.47, 11.18)

- Outer border of collapsed (relaxed) lung is seen (degree of collapse depends upon the size of the pneumothorax).
- Lung markings beyond the lung border are absent.

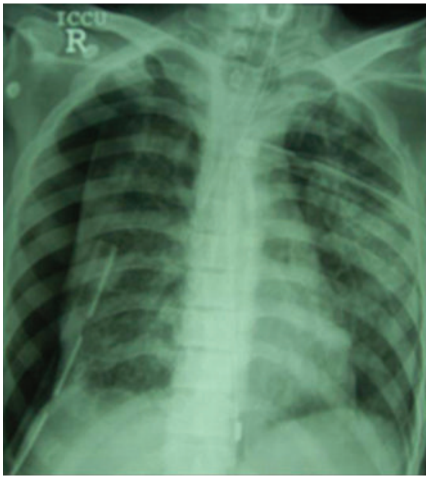

Figure 11.18 Right-side pneumothorax with intercostal drain.

- Mediastinal shift to opposite side. Shift of the mediastinum depends upon the pressure in the pleural cavity.
- For diagnosis of hair-line pneumothorax, X-ray chest in expiratory phase is taken.

Tension pneumothorax (Fig. 11.19)

- Collapsed lung at the hilum
- Depressed hemidiaphragm
- Widened intercostal spaces
- Shift of mediastinum to the opposite side

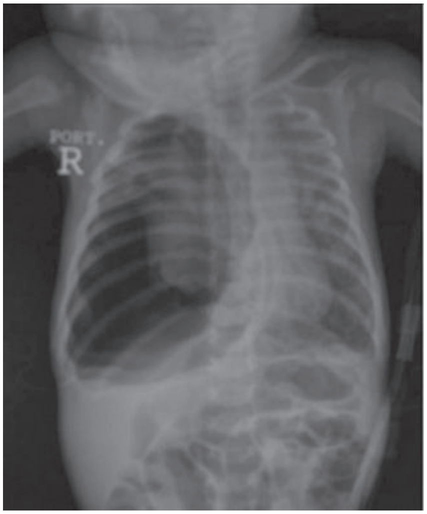

Figure 11.19 Tension pneumothorax with marked shift of mediastinum to the opposite side.

Hydropneumothorax (Fig. 4.49)

In addition to the features of pneumothorax, X-ray shows the presence of air–fluid level. Multiple fluid levels suggest loculation.

Widening of superior mediastinum (Fig. 4.52)

- Lymphadenopathy (TB, metastasis, lymphoma, leukemia, sarcoidosis)
- Aortic arch aneurysm (Figs. 3.62, 11.20)
- Retrosternal thyroid
- Thymoma
- Dermoid cyst
- Mediastinal fibrosis

CARDIOVASCULAR SYSTEM

Chest X-ray is part of routine evaluation of a cardiac patient. Posteroanterior and lateral chest X-ray films with or without barium swallow are adequate. X-ray is reported as follows:

- Name, date, view. Note right and left sides of the X-ray
- Positioning and exposure (technical abnormalities)
- Bony cage (spine, ribs, sternum)
- Cardiac size and shape
- Lung fields (pulmonary vasculature, lung parenchyma, pleural spaces)
- Upper abdomen (positions of fundic air bubble, liver, spleen)
- Other shadows (calcification, sutures, prosthetic valve, foreign bodies)

Technical abnormalities

An overexposed X-ray produces spurious pulmonary oligemia while an underexposed X-ray mimics pulmonary hyperemia or even a lung disease. Rotation of the patient can change prominence of chambers and vascular shadows.

Developmental thoracic cage abnormalities Thoracic cage abnormalities may be associated with congenital heart disease.

- Straight back syndrome and pectus excavatum cause an apparent cardiomegaly on PA view (a lateral film resolves the issue).
- Scoliosis alters the shape of cardiac silhouette.
- Rib notching is present with coarctation of aorta. It is usually seen on 4th to 9th ribs. Rib notching is due to collaterals.
- Sternotomy sutures and clips are seen in operated patients.

Rib notching

- Coarctation of aorta (Fig. 3.48)
- Superior vena caval obstruction
- Pulmonary atresia
- Fallot's tetralogy
- Blalock–Taussig shunt
- Neurofibromatosis

Cardiac size and shape

Normal heart shadow

- Right heart border is formed from above downwards by superior vena cava, right atrium and inferior vena cava.
- Left heart border is formed from above downwards by aortic knuckle (at the level of second intercostal space), pulmonary artery (at the level of third intercostal space), left atrial appendage and left ventricle. The cardiophrenic angle may be occupied by a pad of fat which produces a low-density shadow.
- Inferior heart border is not visible as it is contiguous with the diaphragm.
- Right ventricle does not contribute to the heart border in PA view of the chest. In the lateral view, it forms most of the anterior heart border.

Heart size

Heart size is assessed by calculating the cardiothoracic ratio. Normally, it is 50–55%. Alternatively, on a standard PA view, taken at a distance of 6 feet, transverse diameter of heart can be directly measured. Normal value is 16 cm for men and 15 cm for women. A change of more than 2 cm compared with an earlier X-ray is considered abnormal.

Cardiomegaly

Cardiomegaly can be

- Generalized – Its causes are pericardial effusion (Fig. 3.50), dilated cardiomyopathy (Fig. 3.53) and advanced heart failure (Fig. 3.31).
- Localized enlargement is due to chamber enlargement.

Lung fields

Main pulmonary artery

The normal size of main pulmonary artery is less than 16 mm in men and 15 mm in women.

Enlarged/dilated pulmonary artery

- Left to right shunt (atrial septal defect [ASD], ventricular septal defect; Figs. 3.55, 3.56)
- Pulmonary hypertension (primary or secondary)
- Poststenotic dilatation (pulmonary stenosis)

Pulmonary plethora

- Enlarged main pulmonary artery
- Prominent pulmonary arterial and venous markings
- Vascular shadows visible in the outer third of lung fields
- Equilibration of blood flow in the upper and lower lung fields; normally the blood flow is more in the lower pulmonary arteries

Pulmonary plethora

Left to right shunt

Without cyanosis

- Atrial septal defect (Fig. 3.55)
- Ventricular septal defect (Fig. 3.56)
- Patent ductus arteriosus

With cyanosis

- Single atrium or ventricle
- Transposition of great vessels
- Eisenmenger complex (Fig. 3.57)

Increased cardiac output

- Anemia
- Thyrotoxicosis
- Pregnancy
- Chronic liver disease
- Paget's disease (PD) of bone
- Systemic arteriovenous fistulae

Pulmonary oligemia

- Small or nonvisible pulmonary artery
- Fewer pulmonary vascular shadows

Pulmonary oligemia

- Tetralogy of Fallot (Fig. 3.59)
- Pulmonary stenosis
- Pulmonary atresia

In localized pulmonary parenchymal diseases, uneven vascularity (oligemia) of lung fields is present.

Pulmonary arterial pruning

- It is due to the development of pulmonary hypertension in patients with left-to-right shunt (see Fig. 3.57). The X-ray shows a pruned tree appearance, i.e. enlarged main and proximal branches of pulmonary arteries with rapid tapering.
- Differential diagnosis of prominent vascular hilar shadows is from hilar lymphadenopathy. Enlarged lymph nodes have a lobulated appearance unlike the smooth border of pulmonary artery. A contrast CT distinguishes between the two.

Note – Pulmonary disorders also cause PHT.

Pulmonary venous hypertension (increased pulmonary venous vascularity)

It is due to back pressure transmitted from left heart chambers to pulmonary veins. X-ray findings are

- Upper lobe veins as large or larger than lower lobe veins
- With pulmonary venous pressure greater than 25 mmHg, interstitial edema and Kerley A and B lines are visible (Fig. 3.27). 'B' lines are horizontal, basal, peripheral, nonbranching shadows while 'A' lines are irregular and spread out from hilum into the mid and upper zones
- Pulmonary edema
- Pulmonary hypertension in long-standing cases
- Hemosiderosis in long-standing cases

Interstitial edema

- Left ventricular failure
- Mitral valve disease
- Constrictive pericarditis
- Pulmonary veno-occlusive disease

Note – Prominent interstitial shadows are a feature of many primary lung diseases.

Chamber enlargement

Vena cava

Distended (prominent) superior and inferior vena cava are present in vena caval obstruction and congestive cardiac failure.

Right atrial enlargement

It produces prominence of the right heart border.

Right ventricular enlargement

It is difficult to make out right ventricular enlargement on a PA view. On PA view, it manifests as upward and lateral displacement of cardiac apex. On lateral view, it causes forward bulging of cardiac border with diminished retrosternal air space and increased area of contact with the sternum.

Left atrial enlargement (Fig. 3.24)

It may involve left atrial appendage, body or both. There is

- Straightening of the left heart border due to enlarged left atrial appendage. Initially, there is obliteration of normal concavity and then a bulge appears between the pulmonary conus and the left ventricle
- Double atrial shadow
- Buttressing of right-side heart border (left atrium [LA] protrudes out on the right heart border)
- Posterior and upward elevation of left main bronchus with widening of the angle of carina
- On lateral view with barium swallow, posterior displacement of esophagus (Fig. 3.25)

Left ventricle

- Left ventricular hypertrophy (LVH) causes rounding of the cardiac apex. The left border forms a larger part of a smaller arc. Cardiomegaly indicates left ventricular dilatation with failure
- With left ventricular enlargement (Fig. 3.49), there is
  - ❑ Cardiomegaly
  - ❑ Displacement of cardiac apex, downwards, outwards and to the left

Left ventricular aneurysm

Left ventricular aneurysm is seen as a localized bulge on the left heart border (Fig. 3.14).

Aortic dilatation

- Prominence of ascending aorta
- Prominence of aortic knuckle
- Prominence of lateral border of descending thoracic aorta due to dilatation or aneurysm (visible through the cardiac silhouette)

Other shadows

Calcification/opacities

Calcification can involve any cardiac structure. Common sites are

- Pericardium (constrictive pericarditis; Fig. 3.51)
- Aortic and mitral valves
- Aorta (ascending, arch, aortic knuckle, descending aorta; Figs. 11.20, 11.21)
- Ventricular aneurysm
- Rarely myocardium and endocardium
- Prosthetic valve (Fig. 11.22)
- Superimposed thoracic cage and soft tissue pathologies

X-ray appearances of specific cardiac disorders

Pulmonary edema (Fig. 3.30)

- Bilateral confluent alveolar shadows (may be localized)
- Perihilar opacities with bat-wing appearance

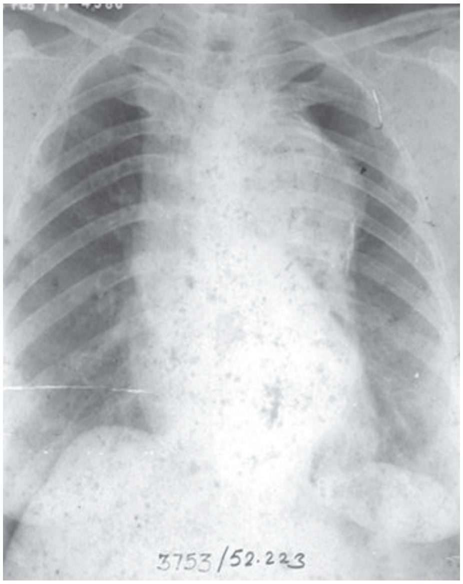

Figure 11.20 Aneurysm of arch of aorta with calcification.

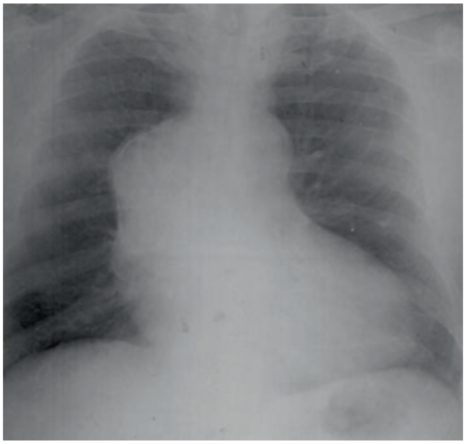

Figure 11.21 Aneurysm of arch and ascending aorta with calcification.

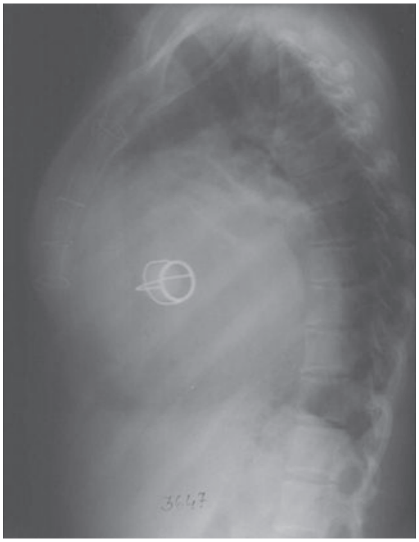

Figure 11.22 Prosthetic mitral valve.

- Blunting of hilar shadows
- Endobronchial cuffing
- Pleural effusion
- Prominent interlobar fissures
- Pseudotumor (vanishing tumor of the lung)
- Heart size variable

Differential diagnosis of pulmonary edema is from infection. Pulmonary edema is

- Rapid in onset
- Usually bilateral
- Lacks fever and other features of infection
- Resolves rapidly with treatment

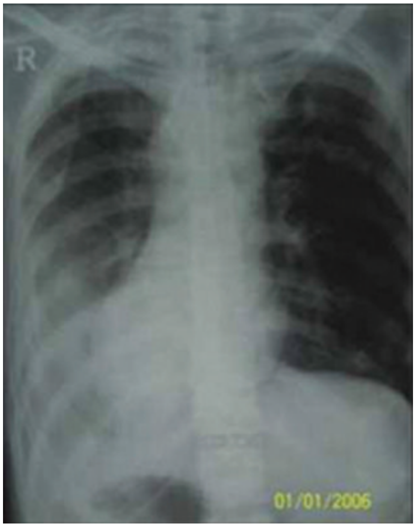

Figure 11.23 Dextrocardia with situs inversus.

Dextrocardia (Fig. 3.13)

Isolated dextrocardia

- Heart situated in the right hemithorax
- Left hemidiaphragm higher than the right hemidiaphragm
- Normal position of liver, spleen and stomach

Dextrocardia with situs inversus (Fig. 11.23)

- Heart situated in right hemithorax
- Liver on the left side
- Spleen and stomach on the right side

Mitral stenosis (Fig. 3.27)

X-ray findings are due to

- Enlarged LA
- Pulmonary venous hypertension
- Pulmonary arterial hypertension (Fig. 3.28)
- Mitral valve calcification

Mitral incompetence

- Cardiomegaly due to left atrial and left ventricular enlargement
    - ❑ Pulmonary venous congestion
    - ❑ Right ventricular enlargement
    - ❑ Mitral valve calcification (±)

Often, there is combined mitral stenosis and mitral incompetence (Figs. 3.39, 3.40).

Aortic stenosis

- Left ventricular hypertrophy
- Left ventricular dilatation with failure
- Poststenotic dilatation of ascending aorta may be seen
- Valve calcification

Aortic incompetence

- Cardiomegaly due to left ventricular dilatation
- Pulmonary edema

Pericardial effusion (Fig. 3.50)

- Large globular cardiac silhouette
- Clear lung fields
- Screening of chest shows diminished cardiac pulsations. 2D echocardiogram confirms the presence of pericardial effusion

Constrictive pericarditis

- Normal or enlarged heart size
- Straightening of right heart border with smoothening of its contours
- Pericardial calcification may be present (Fig. 3.51); better seen and located by fluoroscopy
- Pulmonary congestion (±)

Pericardial cyst

It is seen as a well-defined opacity bordering the heart border.

Atrial septal defect (Fig. 11.24)

- Cardiomegaly due to right atrial and right ventricular dilatation
- Prominent main pulmonary artery
- Pulmonary plethora
- With reversal of shunt, pulmonary plethora is replaced by pruning of pulmonary arteries

Ventricular septal defect (Fig. 3.56)

X-ray is abnormal with significant (large) shunt.

- Cardiomegaly (biventricular hypertrophy)
- Pulmonary plethora
- Prominent pulmonary artery. Pruning of pulmonary arteries with reversal of shunt (Fig. 3.57)

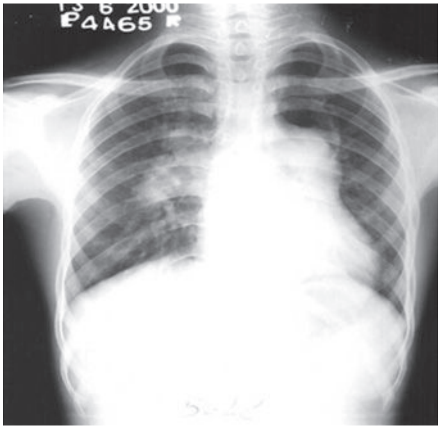

Figure 11.24 ASD with markedly dilated proximal pulmonary arteries.

Patent ductus arteriosus

X-ray is abnormal with significant shunt.

- Prominent LA, left ventricle and ascending aorta
- Increased pulmonary vascular markings

Tetralogy of Fallot (Fig. 3.59)

- Boot-shaped heart
- Concave main pulmonary artery segment
- Pulmonary oligemia
- Right-sided aortic arch (in 25%)
- Rib notching may be present

Aneurysm of arch of aorta (saccular aneurysm; Figs. 3.62, 11.20)

- Widening of mediastinum
- Calcification in the wall of the aneurysm

Calcification of ascending aorta

- Syphilitic aortitis
- Dissection of aorta
- Atherosclerosis
- Monckeberg's medial necrosis
- Marfan's syndrome

Coarctation of aorta (Figs. 3.48, 3.49)

- Rib notching due to collaterals, usually of 4th to 9th ribs
- Post stenotic dilatation of aorta

- Figure of 3 sign, due to
  - Dilated left subclavian artery
  - Coarcted aortic segment
  - Poststenotic aortic dilatation
- Same combination produces E sign on barium-filled esophagus

Right-sided aortic arch

- Indentation of trachea on the right side
- Absence of aortic arch (shadow) on the left side

Pulmonary embolism

Pulmonary embolism can be

Acute massive PE

(A good-quality film is necessary for detection of PE)

- Enlarged heart silhouette (±)
- Localized area of under perfusion of lung
- Prominent pulmonary artery with a cutoff (may be seen)
- Pulmonary angiography (conventional or CT angiography) is necessary to confirm the diagnosis

Subacute PE

- Elevated hemidiaphragm
- Collapse of involved area of lung
- Infarction (a triangular opacity butting on the pleural surface or fissure; common site is base of the lung)
- Pleural effusion

Infarction may heal completely with no residual shadow or with scarring.

Chronic pulmonary thromboembolism

- Features of PHT, except that pruning of vessels is patchy and is associated with hypertranslucent areas of lung.

Renal artery stenosis (Fig. 11.25)

Arteriography is the gold standard for the diagnosis of renal artery stenosis (RAS). Renal artery stenosis may involve main renal artery or its branches.

Common causes are atherosclerosis (in men above 50 years of age), fibromuscular dysplasia (in young women) and aortoarteritis.

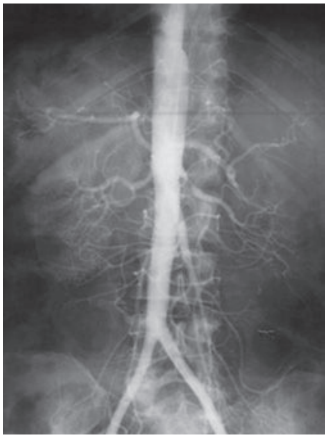

Figure 11.25 Renal artery stenosis due to fibromuscular dysplasia.

Aortoarteritis (Figs. 3.64, 3.65)

Imaging is essential for the diagnosis of aortoarteritis. Catheter-directed contrast angiography is the gold standard. Its disadvantages, especially for serial monitoring, are risks of thromboembolism and significant exposure to dye and radiation.

Computed tomography contrast, MR angiography and US Doppler are alternative modes of diagnosis.

Arteriography shows

- Irregular intimal surface of the aorta or its branches
- Poststenotic dilatation
- Saccular aneurysm
- Occlusion

GASTROINTESTINAL TRACT

Conventional gastrointestinal radiology includes

- Plain X-ray abdomen
- Barium studies

Plain X-ray abdomen

Indications

- Suspected perforation
- Intestinal obstruction
- Renal colic
- Megacolon

Antero posterior erect view is usually ordered. Alternative views are lateral decubitus or supine. The X-ray should include both the diaphragms and the pelvic brim. Lateral decubitus film can detect as little as 1 ml of free air.

- Interpretation of the X-ray depends upon the density of the shadows
  - ❑ Bones and calcific shadows look white
  - ❑ Fluid shadows look light gray
  - ❑ Fat shadows look dark gray
  - ❑ Air shadows look dark
- Intensely white shadows are due to metallic bodies
- Pneumoperitoneum is seen as a dark, crescentic air shadow below both the diaphragms outlining the falciform ligament.

Causes of pneumoperitoneum

- ❑ Perforation of a hollow viscus (e.g. secondary to ulcer, neoplasm)
- ❑ Postlaparotomy or laproscopic surgery
- ❑ Postperitoneal dialysis

Note – A posteriorly situated perforation may result in retroperitoneal collection of air, when air is seen around the kidneys, adrenal glands and psoas muscles and not under the diaphragms.

Sometimes, colon interposes between the liver and the diaphragm – the ***Chilaiditi's syndrome*** (Fig. 11.26).

Intestinal obstruction

Intestinal obstruction is diagnosed by the presence of fluid levels. Normally, only a few air–fluid levels are present in the small intestine. These are

- Located centrally
- Less than four in number
- Less than 2.5 cm in diameter

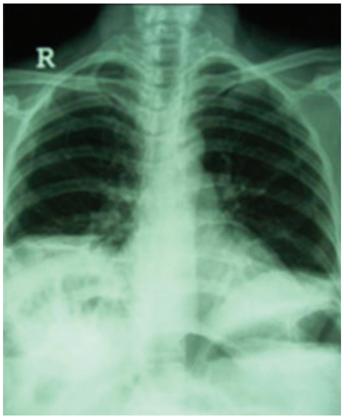

Figure 11.26 Chilaiditi's syndrome.

In intestinal obstruction, the findings are

- Multiple air–fluid levels (greater than 4)
- Centrally situated with small-bowel obstruction and peripherally with large-bowel obstruction
- Air–fluid levels are greater than 2.5 cm in diameter in small-bowel obstruction and greater than 5 cm in diameter in large-bowel obstruction

Barium studies

Types of barium studies are

- Barium swallow (for esophagus)
- Barium meal (for stomach and duodenum)
- Barium meal follow through (for stomach, duodenum and intestine)
- Small-bowel enema or enteroclysis (for small intestine)
- Barium enema and double-contrast enema (for large intestine)

Two types of contrast media are used

1. **i.** Water soluble – This is preferred when perforation is suspected. However, this can cause pulmonary edema if aspirated and also can cause allergic reactions.
2. **ii.** Barium sulfate – This gives good mucosal definition and is nonallergic. It is preferred if aspiration is likely but is contraindicated with suspected perforation.

Barium swallow

Achalasia cardia (Fig. 11.27)

- Dilated esophagus with air–fluid level and food particles
- Narrow esophageal sphincter with a smooth, tapered appearance (bird's beak appearance)
- Absence of progressive peristaltic contractions during swallowing
- Absence of gas in fundus of the stomach
- A pulsion diverticulum in mid or lower esophagus may be present

Hiatus hernia

- Plain X-ray may show a ring shadow with a fluid level (seen through the cardiac silhouette).
- Barium swallow findings – In sliding hiatus hernia (HH), gastroesophageal junction is seen sliding up in the chest (Fig. 2.7).

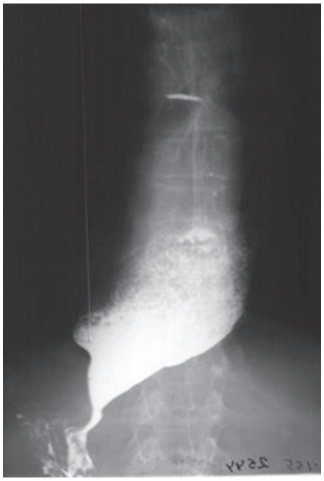

Figure 11.27 Achalasia cardia – Note – beak-like appearance of lower esophageal sphincter with proximally dilated esophagus.

- In rolling HH (paraesophageal hernia), stomach bulges into the chest along the side of esophagus. The gastroesophageal junction remains intra-abdominal (Fig. 11.28).

Differential diagnosis of HH

- Carcinoma of lower end of esophagus
- Peptic stricture

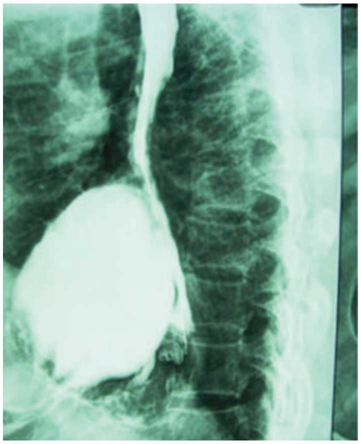

Figure 11.28 Barium swallow (lateral view) – Paraesophageal hernia.

Carcinoma esophagus (Fig. 11.29)

- Irregular filling defect with rat-tail appearance (see Table 11.1 for D.D. from achalasia cardia)
- Tracheoesophageal fistula may be present
- Endoscopy with cytology and biopsy essential for a definite diagnosis

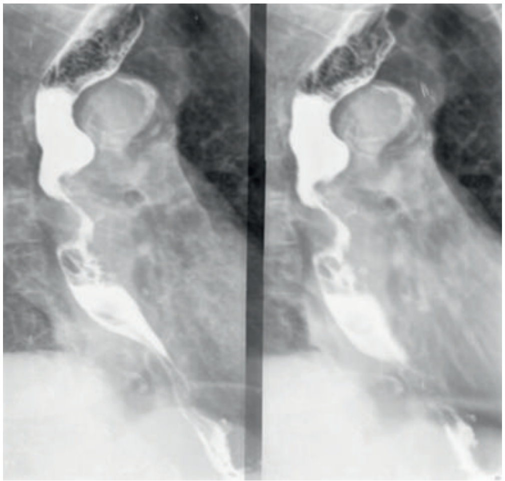

Figure 11.29 Malignancy of esophagus below the level of carina, producing concentric narrowing.

Table 11.1 Differences between achalasia cardia and carcinoma esophagus

	Achalasia cardia	Carcinoma esophagus
Site of pathology	Lower end of esophagus	Any part of esophagus; commonest site being mid esophagus
Appearance of the narrow segment	Smooth, central	Irregular, eccentric
Mobility	Mobile (moves with cardiac pulsations)	Fixed
Megaesophagus	Develops in long-standing cases	Unlikely

Esophageal candidiasis (Fig. 11.30)

Linear, plaque-like lesions of 2–3 mm size produce

- Granular appearance of esophagus
- Endoscopic and microbiological examination are necessary for confirming the diagnosis

Esophageal varices (Fig. 2.23)

These are seen as

- Thickened longitudinal esophageal folds with a worm-eaten appearance

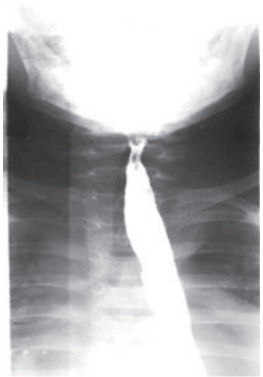

Figure 11.30 Esophageal candidiasis.

Esophageal web (Fig. 11.31)

(Plummer–Vinson or Peterson–Kelly syndrome)

- A rare complication of iron-deficiency anemia
- Usually occurs in upper esophagus

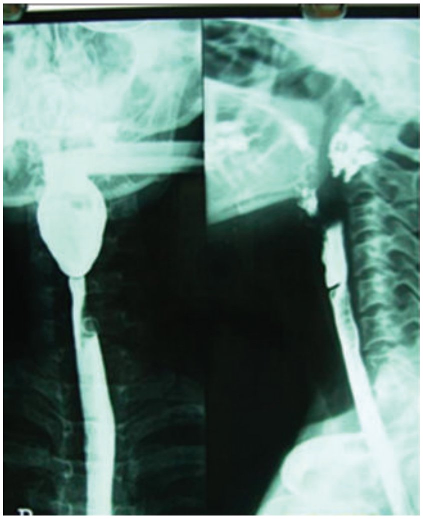

Figure 11.31 Anterior esophageal web.

Barium meal studies

Benign gastric ulcer

- Usual site of ulcer is the lesser curvature of stomach
- Ulcer crater projects beyond the lumen of the stomach with a thin, sharply defined lucent line at the base of ulcer crater (Hampton line). A lucent ulcer collar that separates ulcer crater from the gastric lumen
- Symmetrically radiating mucosal folds
- Variable ulcer size

Endoscopy is more sensitive and diagnostic than barium meal for the diagnosis of gastric ulcer of stomach

Malignant gastric ulcer

- Irregular, large ulcer crater that protrudes into the stomach lumen
- Asymmetric mucosal folds
- Sensitivity of barium studies for diagnosis of malignant ulcer is poor

Endoscopy with biopsy and cytology are essential for a definite diagnosis.

For differences between peptic and malignant ulcers of stomach see Table 11.2.

Table 11.2 **Differences between peptic and malignant ulcers of stomach**

Peptic ulcer	Malignant ulcer
Symmetrical ulcer	Asymmetrical ulcer
Smooth margin	Irregular margin
Symmetrical radial folds	Asymmetrical folds
Radiolucent band between ulcer and lumen (Hampton line)	Loss of distensibility Nodularity

Duodenal ulcer (Fig. 11.32)

- Usual site is first part of duodenum
- Other features are similar to benign gastric ulcer

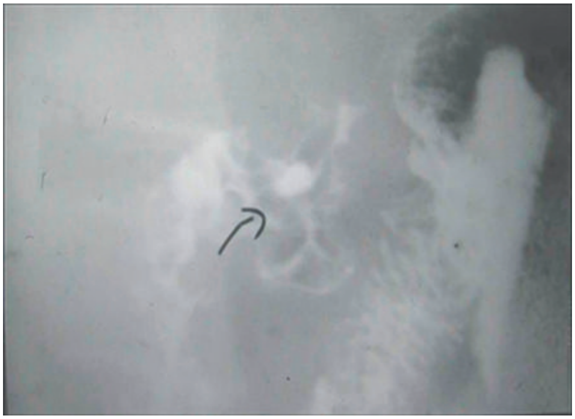

Figure 11.32 Ulcer crater in the duodenum with radiating mucosal folds.

Barium meal follow through studies

Malabsorption syndrome

- Diffuse, poorly contractile small-bowel loops with flocculation and segmentation of barium
- Featureless duodenum and jejunum
- Reversed jejunoileal fold pattern

Crohn's disease (Figs. 2.33, 11.33)

- Initial lesion, aphthous ulceration
- Later deep transverse ulcers with intervening edematous mucosa (rose thorn ulcers) producing a cobblestone appearance
- String sign (a markedly narrowed segment of ileum) – a characteristic finding
- Separation of bowel loops
- Additionally there may be polyps, stricture
- Internal fistula(e)
- Shrinkage of mesenteric border with pseudosacculation

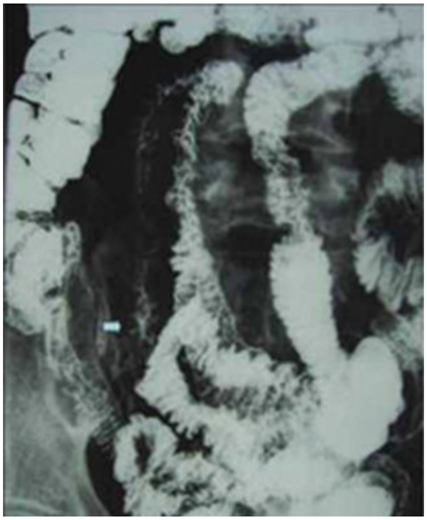

Figure 11.33 Crohn's disease – Barium meal follow through shows rose-thorn ulcers.

Intestinal TB (Figs. 2.32, 11.34A, B)

The commonest site of involvement is ileocecal junction and the following signs are seen.

- Hypersegmentation and flocculation of barium (early signs)
- Later, transverse mucosal ulceration with thickened mucosal folds are seen
- Sterling sign – Rapid transit of barium with lack of retention of barium in the terminal ileum, a characteristic sign

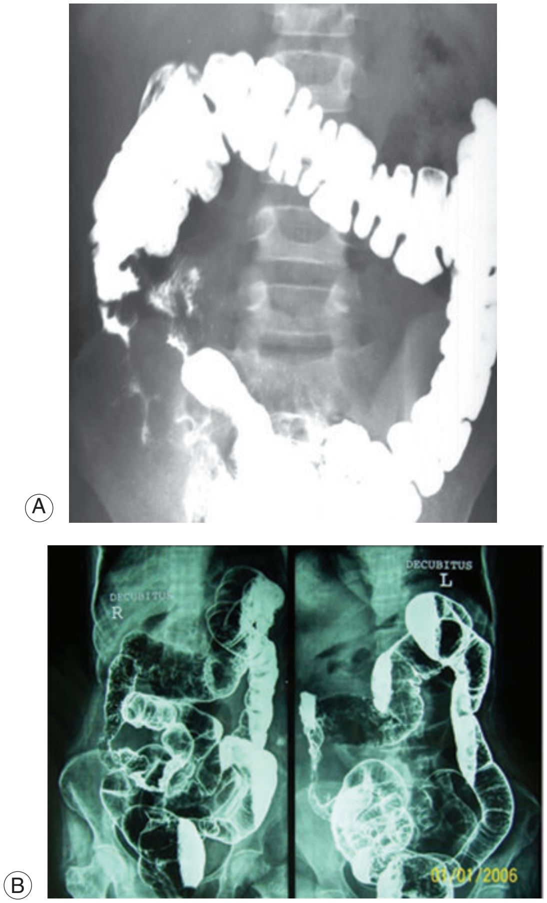

Figure 11.34 (A) Ileocecal TB. (B) Double-contrast barium – Ileocecal TB.

- Inverted umbrella sign (due to thickened ileocecal valve) (Fleischner's sign)
- Internal fistula (rare)

Thickened mucosal folds of small bowel

- Lymphoma
- Giardiasis
- Amyloidosis
- Paraproteinemia
- Zollinger–Ellison syndrome
- Intestinal lymphangiectasia

Separation of small-bowel loops

- Tuberculosis
- Crohn's disease

- Lymphoma
- Radiation enteritis
- Amyloidosis
- Small-bowel tumors

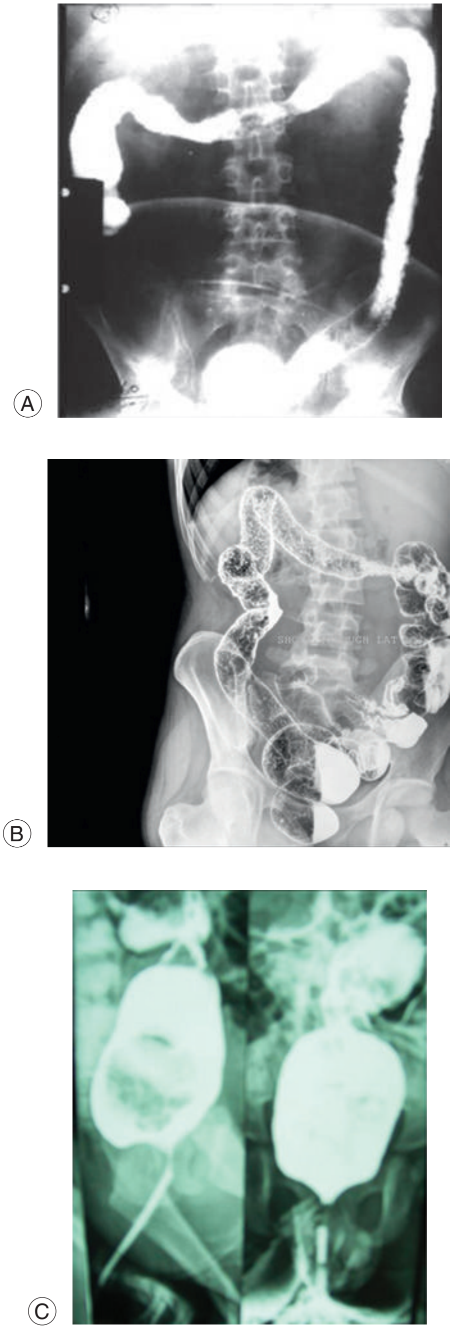

Figure 11.35 (A) Narrowed irregular ulcerated colon due to ulcerative colitis. (B) Double-contrast barium enema with tiny ulcers due to ulcerative colitis. (C) Hirschsprung's disease – Note narrow colonic segment with proximal dilatation.

Barium enema studies
(Figs. 11.35A, B)

Ulcerative colitis

Barium enema examination should not be done in the presence of severe ulcerative colitis with dilated colonic segments. Only plain abdominal X-ray is indicated. The barium enema shows

- Fine granular mucosa
- Thickened mucosa
- Pseudopolyps
- Colonic shortening
- Colonic narrowing
- Increased presacral space (greater than 1 cm)

Diverticular disease

Sigmoid colon is the commonest site of involvement. Usually, there are multiple diverticula, seen as outpouching of barium. Perforation (when present) is seen as leaking of barium from the diverticulum which may fill an abscess cavity.

Colorectal cancer

Variable appearances

- An ulcer with overhanging margins
- Polypoid filling defect
- An apple-core appearance

Hirschsprung's disease (Fig. 11.35C)

- Dilatation of colon
- Colon filled with feces
- Funnel-shaped transition zone
- Narrowed rectum

Ischemic colitis

Produces a characteristic thumb printing appearance

Differential diagnosis of thumb printing

- Ischemic colitis
- Ulcerative colitis
- Amebiasis
- Crohn's disease
- Pseudomembranous colitis
- Lymphoma

MUSCULOSKELETAL SYSTEM

For rheumatic disorders, see Chapter 9.

Bone disorders

Plain X-ray is the primary imaging modality in bone disorders. Computed tomography and MRI are necessary for more detailed definition of bone and associated soft tissue pathologies.

Bone X-ray is read as follows:

- Name, date
- Soft tissues
- Periosteum
- Cortical and trabecular bone
- Deformity
- Fracture
- Dislocation

X-ray appearances of specific bone disorders

Tuberculosis of spine (Pott's spine; Figs. 11.36A, B)

Lower thoracic and upper lumbar spines are the common sites of involvement

- Narrowing of intervertebral disc(s)
- Erosion of vertebral body(ies)
- Wedge-shaped collapse of vertebral body(ies)
- Paravertebral abscess
- Fusion of contiguous vertebrae
- Computed tomography/magnetic resonance imaging (CT/MRI) provide a better definition of the pathology

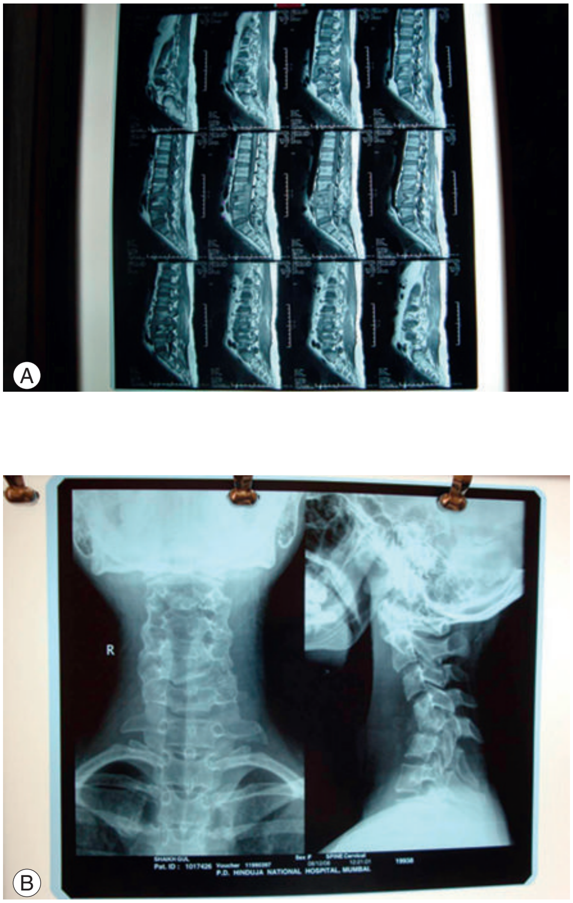

Figure 11.36 (A) Tuberculous osteitis of lumbar 3, 4, 5 vertebrae with cold abscess. (B) TB of cervical 4th and 5th vertebrae.

Scurvy (Fig. 11.37)

X-rays are of diagnostic value only in children. The findings are

- Compressed epiphysis
- A white line of calcified irregular cartilage in the metaphysis
- A zone of rarefaction or linear fracture, proximal and parallel to the white line (specific sign of scurvy)
- In the healed stage, subperiosteal hematoma, with elevated and calcified periosteum may be seen

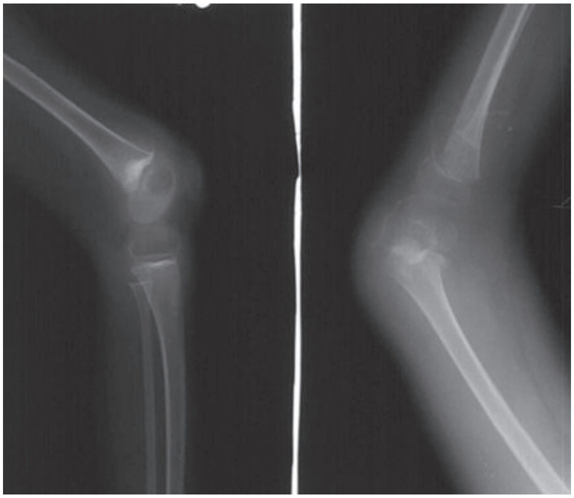

Figure 11.37 Scurvy – Knee X-ray.

Rickets (Figs. 11.38A, B)

The findings vary with the stage of the disease.

Active stage

- Changes are most marked at the lower ends of radius and ulna. The changes are
  - ❑ Loss of sharp, clear outline of diphyseal ends that become cup shaped with spotty, fringy rarefaction (Fig. 11.38A & B)
  - ❑ Radiolucent bone matrix
  - ❑ Deformities at cartilage–shaft junction due to bending of bones
  - ❑ Greenstick fracture(s)

Healing stage

- Appearance of a thin white line of calcification at the epiphysis is an early sign of healing. With progressive healing, the line becomes denser and thicker.
- Calcification of bone matrix

Osteomalacia (Fig. 9.27B)

- Generalized demineralization of bone
- Deformities of pelvis, spine and lower extremity (triradiate pelvis is a typical finding)
- Pseudofractures (Looser's zones, Milkman's syndrome)
- Biconcave vertebral bodies (codfish vertebrae)
- Rugger jersey appearance of vertebral bodies in osteomalacia secondary to chronic renal failure
- Scintigraphy can pick up Looser's zones before plain X-rays can

Looser's zones

- These are 1–3 mm wide, ribbon-like translucent bands (zones of decalcification) lying at right angles to the cortex and extending up to 1 cm in the bone.
- Resemble fracture.
- Seen at ischiopubic rami, axillary borders of scapulae, ribs, medial borders of upper femora and at lower ends of radius and ulna.

Milkman's syndrome is osteoporosis with multiple fractures seen in osteomalacia.

Osteoporosis

- X-ray is not sensitive enough to detect early osteoporosis. Changes in bone structure are seen only when more than 30% of the bone is lost. Bones show
- Decreased bone density
- Loss of trabeculae
- Cortical thinning
- Tunneling of the cortex

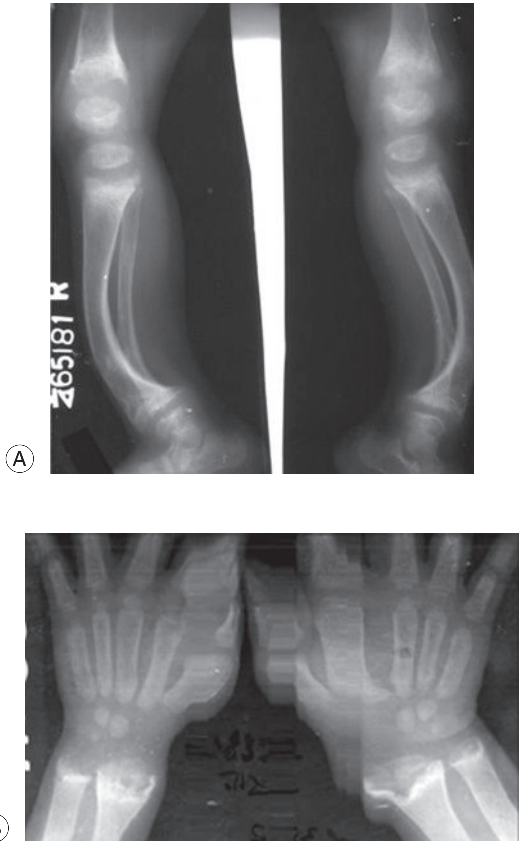

Figure 11.38 (A) Rickets. Note – Widening, fraying and cupping of distal ends of the shaft, and widening of epiphysis and deformity. (B) Note – Widening, fraying and cupping of distal ends of the shaft, and widening of epiphysis and deformity.

Vertebrae show

- Loss of horizontal trabeculae
- Prominent vertical trabeculae
- Prominent cortical end plates
- Loss of vertebral height with increased biconcavity (due to vertebral compression fractures)
- Anterior wedging of vertebrae causing kyphosis
- Rib fractures with exuberant callus formation in osteoporosis secondary to corticosteroid therapy

Note – Vertebral fractures at and above T4 are not due to osteoporosis, but often due to malignancy.

Paget's disease of bone

It may be mono or polyostotic. The X-ray findings are

- Thickening of cortical bone
- Mixed lytic-sclerotic lesions

- Distortion and overgrowth of affected bone(s)
- Fissure fractures of cortical bones on convex surface, unlike the Looser's zones which are seen on concave surface of bone
- Common sites of bone involvement
  - Skull (Fig. 11.39; can cause basilar invagination)
  - Thoracolumbar spine
  - Pelvis
  - Femur

T_c-MDP bone scan is useful to define the extent of the disease and to assess disease activity.

Fluorosis (Fig. 11.40)

- Long bones, spine and pelvis are affected. It is characterized by diffuse osteosclerosis and interosseous membrane calcification (diagnostic abnormality).

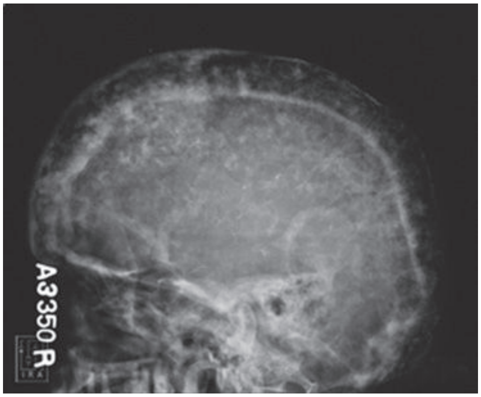

Figure 11.39 Paget's disease of the skull.

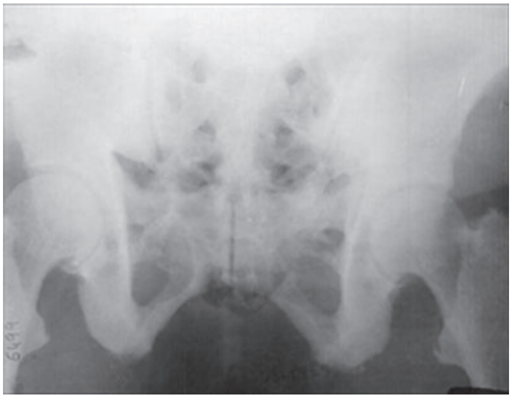

Figure 11.40 Fluorosis – X-ray pelvis shows ligament calcification.

Developmental abnormalities

There are many developmental abnormalities of the spine

- Hemivertebra
- Spina bifida (Fig. 11.41)
- Lumbosacral transitional vertebra
- Klippel–Feil malformation
- Craniovertebral anomalies

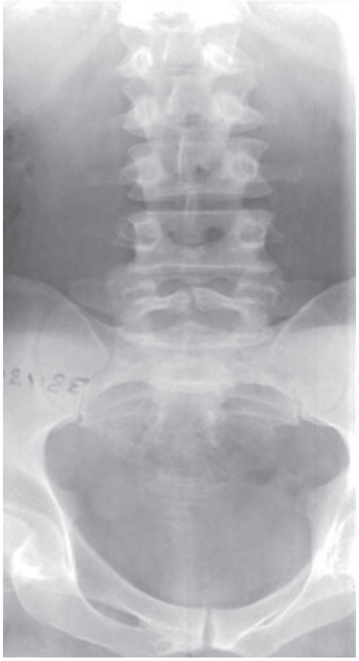

Figure 11.41 Spina bifida, lumbar spine.

NEUROLOGY

Skull

Raised intracranial pressure (ICP)

Changes are seen with long-standing raised ICP.

Changes in children

- Widening of sutures
- Prominent convolutional markings
- Shallow sella turcica
- Erosion of posterior clinoids

Findings in adults

- Silver beaten appearance
- Erosion of posterior clinoids

Widening of sutures

- Raised ICP
- Infiltration (neuroblastoma, lymphoma)
- Defective ossification (e.g. rickets)

Intracranial calcification

Nonpathological

- Pineal body
- Falx cerebri
- Petroclinoid ligament
- Choroid plexus

Pathological

- Infection – Tuberculoma, cysticercosis (Fig. 11.42), healed abscess, hydatid cyst, toxoplasmosis, CMV, rubella
- Vascular – AV malformation
  - ❑ Old subdural hematoma
  - ❑ Atherosclerotic arteries
- Tumors – Meningioma.
- Basal ganglia (Fig. 11.43), glioma, craniopharyngioma
- Others – Hypoparathyroidism, tuberous sclerosis, Sturge–Weber syndrome

Lytic lesions of skull

- Metastasis
- Multiple myeloma (Figs. 3.24, 11.44)
- Histiocytosis
- Active phase of Paget disease of bone (osteoporosis circumscripta)

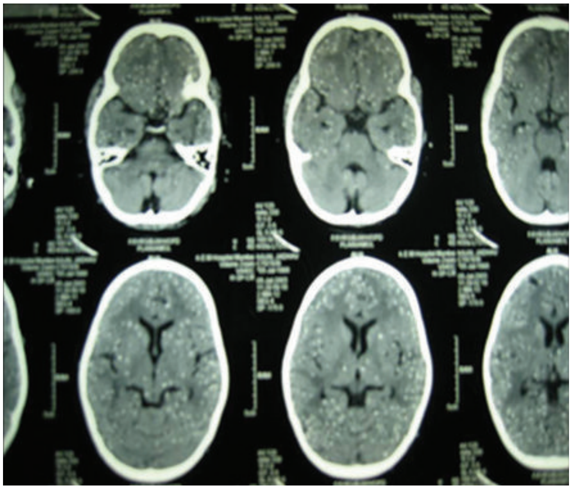

Figure 11.42 Neurocysticercosis (calcification).

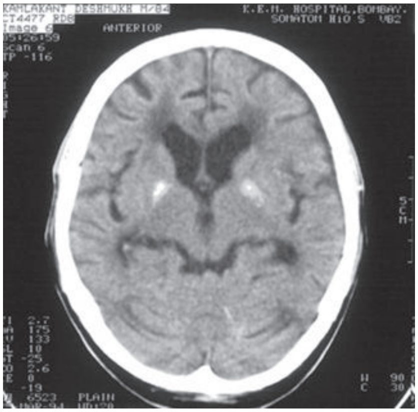

Figure 11.43 Basal ganglia calcification.

Sclerotic lesions of skull

- Meningioma
- Paget's disease of bone
- Sclerotic metastasis
- Fluorosis

Hematology

Thalassemia

X-ray changes are due to chronic hyperactivity of bone marrow.

Skull changes

- Widened diploic spaces
- Hair-on-end appearance due to prominent trabeculae (Fig. 8.12)
- Cortical thinning with loss of definition of outer table

Long bones

- Widening of medullary cavity
- Coarse trabeculae
- Thinned cortex
- Areas of osteoporosis
- Rectangular or biconvex phalanges

Chest X-ray

- Areas of extramedullary erythropoiesis in ribs and cardiomegaly (Fig. 8.13).

Vertebrae

- Osteoporosis
- Compression fracture(s)

Sickle cell anemia

A variety of bone pathologies are encountered. These are

- Avascular necrosis of bone. Hip and shoulder are the most common sites
- Bone infarcts
- Osteomyelitis

Multiple myeloma (Fig. 11.44)

- Osteoporosis (without osteolytic lesions)
- Coarsening of trabecular pattern
- Osteolytic bone lesion(s) (common sites: skull, pelvis, ribs, vertebrae)
- Solitary plasmacytoma of bone involves only one bone (does not produce 'M' protein [Fig. 11.45])
- Drumstick expansion of anterior ends of ribs
- Pathological vertebral fracture(s)
- Spinal deformity

The osteolytic lesions of multiple myeloma do not take up radionuclide; therefore, unlike secondaries, the scan is negative.

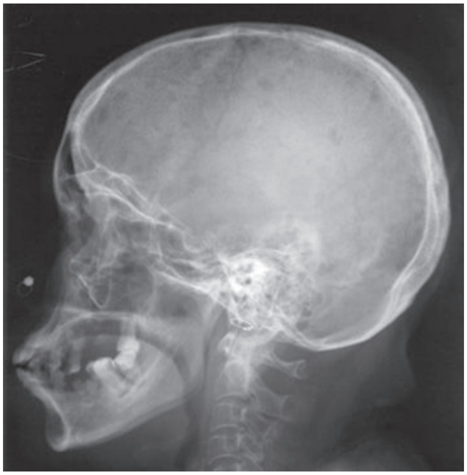

Figure 11.44 Multiple myeloma with osteolytic areas.

Hemophilia

The joint changes are

Early stage

- Soft tissue swelling
- Periarticular demineralization of bones
- Increased radiodensity of synovium due to iron deposition

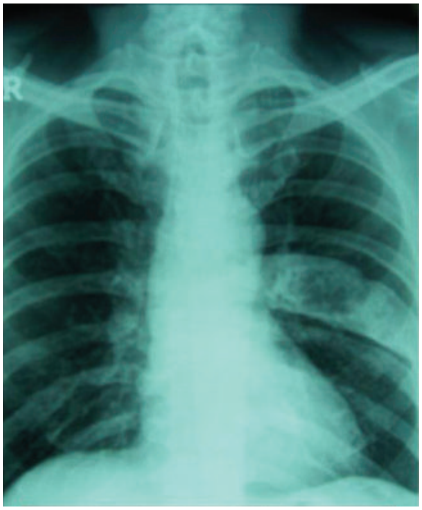

Figure 11.45 Solitary plasmacytoma of rib.

Intermediate stage

- Growth arrest lines
- Widening of femoral and humeral intercondylar notches (specific finding)
- Proximal radial head enlargement
- Tibiotalar deformity (slant)

Late stage

- Cartilage loss, erosions, diminished joint space
- Secondary osteoarthritis (osteophytes, cysts, subarticular sclerosis)
- Disorganization, subluxation of joint
- Bony ankylosis

ENDOCRINOLOGY AND METABOLISM

Acromegaly

Characteristic X-ray changes are seen in different body parts.

Hand

- Thickening of soft tissues
- Widening of articular spaces
- Enlargement of tufts and bases of terminal phalanges
- Periosteal appositions on tubular bones
- Chondrocalcinosis (rare)
- Thickening of sesamoid bones of hand (supposed to be a specific finding)

Foot

- Increased heel pad thickness (greater than 30 mm)

Lumbar spine

- Scalloping of posterior margins of vertebrae
- New bone formation on anterior vertebral surface
- Secondary degenerative changes

Skull

- Widening and deepening of sella turcica (Fig. 7.8)
- Erosion of floor of sella turcica with a double floor
- Increased thickness of calvarium (Fig. 7.8)
- Large air sinuses
- Large mastoid air cells (Fig. 7.8)
- Calcification of nuchal ligament

Spine

- Calcification of spinal ligaments

Diabetes mellitus

There are no specific appearances in diabetes mellitus. The radiological findings can be those of
- Charcot's joint
- Diffuse idiopathic skeletal hyperostosis, a common association (Fig. 7.34)
- Osteomyelitis, a common complication

Neuropathic arthropathy/Charcot's joint in diabetes mellitus

- Midfoot is the commonest site of involvement
- Changes are described as '5Ds'
  - **i.** Dislocation
  - **ii.** Disorganization
  - **iii.** Increased density
  - **iv.** Debris
  - **v.** Joint distension

Three phase technetium scan is useful in making the diagnosis.

Hyperparathyroidism

Osteitis fibrosa cystica is the characteristic radiological finding of tertiary hyperparathyroidism. The radiological changes are

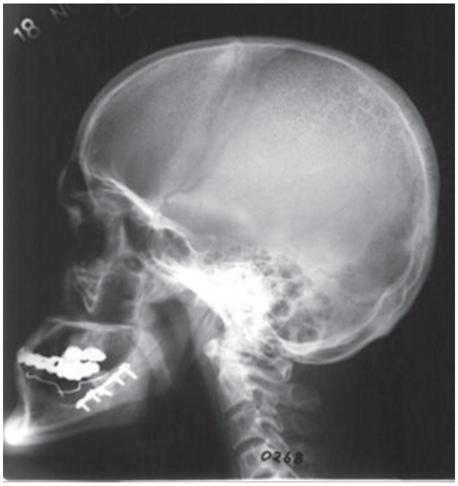

Figure 11.46 Pepper pot skull – Hyperparathyroidism.

Bones

- Bone cysts
- Osteoporosis
- Brown tumor(s)
- Fracture(s)
- Subperiosteal bone resorption on the medial aspect of proximal phalanges (Fig. 7.21)

Skull

- Salt and pepper appearance (pepper pot skull) (Fig. 11.46)

Spine

- Osteoporosis
- Fracture(s)

Teeth

- Loss of lamina dura

Long bones

- Resorption of lateral one-third of clavicle
- Erosion of distal end of femur
- Erosion of medial surface of neck of femur
- Acroosteolysis
- Osteitis fibrosa cystica
- Pathological fractures

Hyperthyroidism

X-ray of the hands may show
- Periosteal bone formation involving proximal phalanges and metacarpals

- Similar changes may be seen in the feet (metatarsals and toes)
- Differential diagnosis is from hypertrophic osteoarthropathy

GENITOURINARY TRACT

Plain abdominal X-rays have poor sensitivity for the diagnosis of renal disorders including renal stones. Other imaging modalities used are

- Urography
- Intravenous urography (IVU; formerly called intravenous pyelography)
- Percutaneous antegrade urography
- Retrograde urography
- Cystourethrography
- Angiography
- Ultrasonography
- Computed tomography scan
- Magnetic resonance imaging
- Radionuclide scanning

For all contrast studies, iodine sensitivity should be excluded.

Horseshoe kidney (Fig. 11.47)

It is a developmental anomaly. The lower poles of the two kidneys are fused across the spine. There is often an associated malrotation of kidneys with the renal pelvis lying anteriorly and the calyces placed posteriorly, laterally or medially.

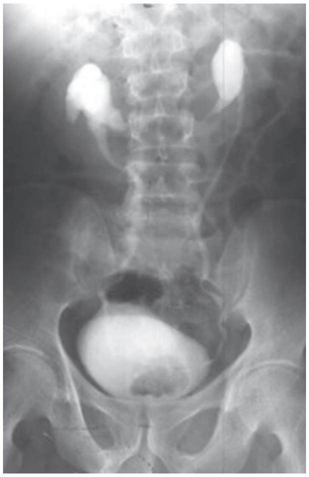

Figure 11.47 IVU – Horseshoe kidney.

Renal calculi

- Plain X-ray can miss calculi if radiolucent and if the patient's preparation is not adequate.
- Intravenous urography can show the site of calculi and hydronephrosis (Figs. 11.48, 11.49, 11.50). Disadvantages of IVU are (1) it can miss small calculi without hydronephrosis; (2) it is a time-consuming procedure; and (3) it carries the risk associated with IV contrast. Intravenous urography is suggested if CT is not possible.
- Ultrasound is simple, inexpensive but can miss small calculi like the IVU.

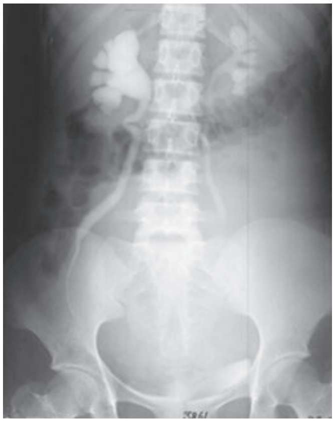

Figure 11.48 IVU – Bilateral hydronephrosis due to outflow obstruction.

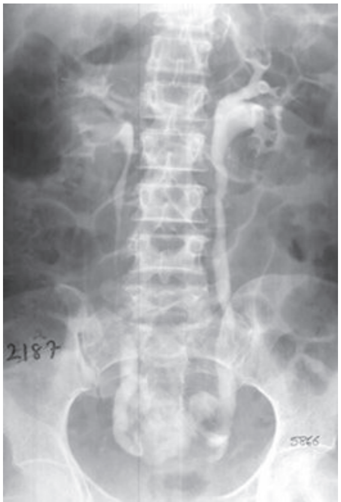

Figure 11.49 IVU – Left pelviureteric junction calculus with hydronephrosis.

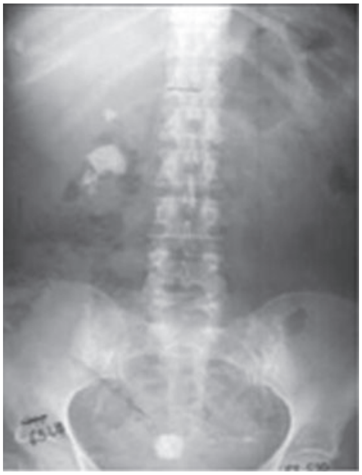

Figure 11.50 Staghorn calculus and calcified fibroid.

- Noncontrast spiral CT can detect location of the calculus and show the degree of obstruction.

Unilateral small kidney

- Unilateral renal artery stenosis
- Congenital hypoplasia

Bilateral small kidneys

- Glomerulonephritis
- Bilateral renal ischemia
- Papillary necrosis

Unilateral large kidney

- Hydronephrosis (Fig. 11.49)
- Tumor (benign or malignant)
- Acute pyelonephritis
- Duplex kidney

Bilateral large kidneys

- Polycystic kidney disease
- Myeloma
- Lymphoma
- Amyloidosis
- Hydronephrosis (Fig. 11.48)

OTHER IMAGING MODALITIES

Ultrasound, CT, MRI, PET scan have added a new dimension to radiological imaging.

Ultrasonography

Ultrasound is a high-frequency vibration produced by piezoelectric materials. It is a tomographic imaging modality. It can be used to study neck, abdomen, pelvis and extremities. Doppler can determine the direction of blood flow and its velocity.

Ultrasonography has many advantages, such as

- Easy accessibility
- Cost effectiveness
- High diagnostic capability
- No radiation hazard
- Safe in pregnancy
- Contrast media not necessary
- Useful for multiple follow-up studies

A major disadvantage of US is that it is operator- and patient-dependent. Further, the resolution is inversely related to the depth of penetration, and therefore, it is not an ideal imaging modality for the study of deeper tissues.

Computed tomography

Advantages

- Computed tomography (CT) overcomes overlap of 3D structures present in conventional X-rays, it being a tomographic imaging modality
- Better visualization of tissues
- 3D construction is possible

Disadvantages

- Expensive
- Not easily accessible
- High radiation exposure
- Contraindicated in first trimester of pregnancy

Computed tomography can be performed with or without contrast (using the usual contrast media). Contrast-enhanced CT should not be performed in a patient with deranged renal function.

Magnetic resonance imaging

Magnetic resonance imaging (MRI) is an improvement on CT. Its advantages are

- Does not involve ionizing radiation
- Can visualize soft tissues better
- Noninvasive
- Permits better visualization structure of internal organs

Disadvantages

- Expensive
- Not easily accessible
- Longer scan acquisition time

The precaution to be followed during the MR study is that the patient should not carry any ferromagnetic substances on his or her person unless MR machine is ferromagnetic compatible.

Absolute contraindications are severe claustrophobia, aneurysm clips, artificial pacemaker and intraocular foreign bodies. Open MRI are now available for claustrophobic patients.

Images are T1 or T2 weighted. T2-weighted images, fat suppressed or STIR images are useful for evaluating pathology while T1 images provide good anatomical information. Gadolinium enhancement improves T1-weighted images.

Below are illustrated some examples of US, CT and MRI.

Liver

Liver abscess (Figs. 2.28, 2.29)

Ultrasound is the diagnostic modality of choice. It can locate the site, determine the size and the number of abscesses and guide aspiration of the abscess (Fig. 2.28). Complications such as rupture can be diagnosed.

Computed tomography is complimentary to US and indicated if US examination does not give a clear diagnosis (Fig. 2.29). Neither US nor CT can differentiate between amebic and pyogenic liver abscesses.

Hydatid cyst of liver (Fig. 11.51)

Ultrasound, CT and MRI appearances are diagnostic if daughter cysts and hydatid sand are present. A simple hydatid cyst is difficult to differentiate from a benign cyst.

Plain X-ray may show curvilinear calcification of the cyst and speckled calcification of the endocyst.

The pathognomonic features of hydatid cyst on US are

- Fluid collection with detached membrane
- Fluid collection with multiple septa (honeycomb appearance)
- Cyst with calcified thick walls

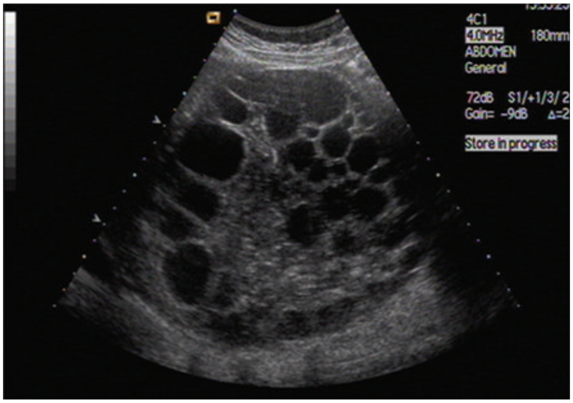

Figure 11.51 Abdominal US – Hydatid cyst of liver with septation.

Hepatocellular carcinoma (Figs. 2.30, 2.31)

- Ultrasound can detect the growth. The growth may be hypoechogenic, echogenic or complex (Fig. 2.30)
- Ultrasound provides information about its size, location, state of rest of the liver, biliary radicals, portal system and lymph node metastasis
- Abdominal CT with contrast characteristically shows tumor hypervascularization in the arterial phase and detects extrahepatic metastasis and the other details as noted under US (Fig. 2.31)
- Magnetic resonance imaging with dynamic gadolinium enhancement is a superior diagnostic modality compared with CT

Hepatic metastasis

- On US, metastasis are seen as multiple, hypoechoic lesions
- On plain CT, these are seen as hypodense lesions which show rim enhancement on contrast-enhanced CT
- On MRI, metastasis is hypointense on T1 and hyperintense on T2-weighted images

Gallbladder and bile ducts

Gallbladder calculi (gall stones) (Fig. 11.52)

Ultrasound is the imaging modality of choice for detecting gallbladder calculi, but it is not sensitive enough to detect common bile duct calculi. Calculi are typically bright (hyperechoic) with acoustic shadowing.

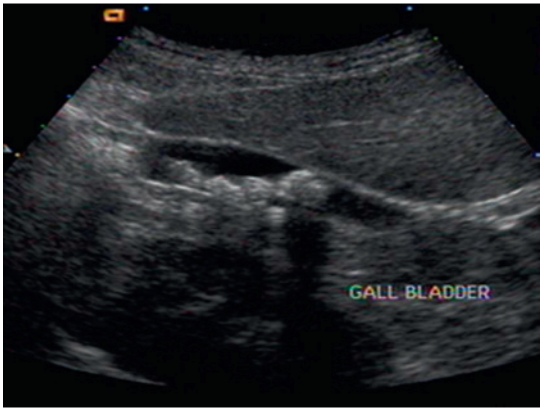

Figure 11.52 Ultrasound gallbladder calculi.

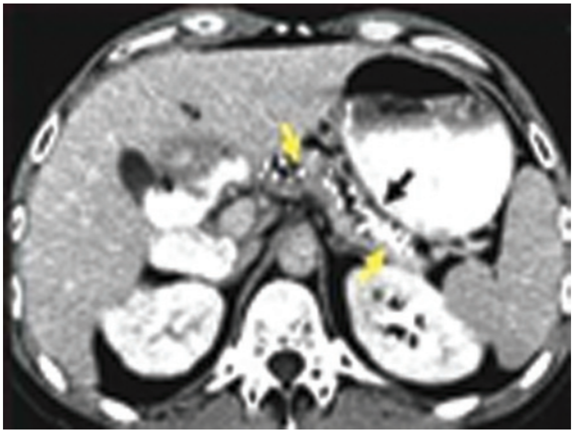

Figure 11.53 Abdominal CT – Chronic pancreatitis with calcification.

Obstructive jaundice

Ultrasound imaging can visualize biliary ducts clearly and determine their size. The US findings with extrahepatic biliary obstruction are

- Dilated bile duct (normal diameter less than 6 mm)
- Dilated intrahepatic bile ducts (normally less than or equal to 2 mm in diameter)
- May detect the cause and site of obstruction, e.g. ductal calculus, cholangiocarcinoma, periampullary carcinoma, mass in the head of pancreas

Thickening of gallbladder wall is a nonspecific finding. It is commonly seen in acute and chronic cholecystitis.

In acute cholecystitis, pericholecystic fluid and intramural gas are specific diagnostic findings.

Computed tomography scan is useful when complications such as perforation and gangrene are suspected.

Pancreas

- Calcification is a characteristic feature of chronic pancreatitis (Fig. 11.53).
- Ultrasound is not a sensitive imaging modality for pancreatic diseases.
- Computed tomography and MRI (indicated if CT is normal) are more sensitive. Magnetic resonance cholangiopancreatography (MRC) may replace endoscopic retrograde pancreaticoduodenography (ERCP) as a diagnostic modality of choice.

Chronic pancreatitis (Fig. 11.53)

CT findings are –

- Dilated pancreatic duct
- Stones in pancreatic duct
- Atrophic or enlarged pancreas
- Pseudocyst(s)
- Abnormal echotexture of pancreas
- Abnormalities of peripancreatic tissues

Pancreatic calcification

- Alcoholic pancreatitis
- Tropical pancreatitis
- Late-onset idiopathic pancreatitis
- Hereditary pancreatitis

Carcinoma of pancreas (Fig. 11.54)

Computed tomography scan is highly sensitive and specific (95%) for the diagnosis of carcinoma of pancreas. It shows

- Altered pancreatic morphology
- Abnormal CT attenuation values
- Obliteration of peripancreatic fat and loss of sharp margins of pancreas
- Vascular involvement
- Lymph node involvement
- Bile duct obstruction
- Dilatation of pancreatic duct

Magnetic resonance imaging is more useful for staging. Endoscopic US has the highest diagnostic accuracy.

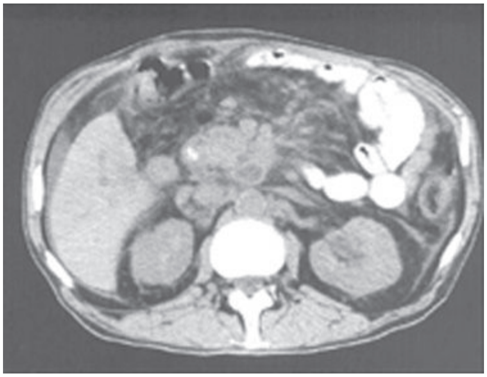

Figure 11.54 Abdominal CT – Carcinoma pancreas.

Abdominal and pelvic calcifications

Most abdominal and pelvic calcifications are clinically insignificant. These are arterial (atherosclerosis), venous (pelvic phleboliths) and calcified lymph nodes.

Other sites of calcification are

- Pancreas (chronic pancreatitis)
- Liver (healed granuloma, healed abscess, hydatid cyst; rarely, hepatoma and metastasis may show calcification)
- Gall bladder (gall stones)
- Genitourinary tract (renal and ureteric calculi, nephrocalcinosis; rarely, renal tumors and cysts)
- Ovary (usually due to a benign cause)
- Uterus (fibroid; Fig. 11.50)
- Prostate (calculi; carry no diagnostic significance)
- Bladder wall (tumor, TB, schistosomiasis)
- Vas deferens (diabetes)
- Soft tissues (e.g. guinea worm; Fig. 11.55)

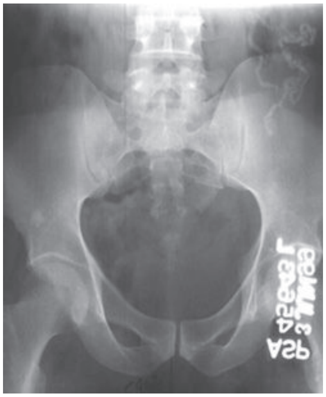

Figure 11.55 Guinea worm calcification.

Extraintestinal air collection (excluding peritoneal)

- Biliary tree (postsphincterotomy, gall stone ileus, bile duct and bowel anastomoses)
- Portal vein (bowel infarction)
- Abscess
- Urinary tract

Neurology (CT and MRI)

Stroke

Computed tomography is the investigation of choice, mainly to exclude cerebral hemorrhage, subdural or epidural hematoma, bleed in a tumor and a rapidly growing space occupying lesion.

Computed tomography findings in cerebral infarction are –

- In the first few hours, changes are subtle (e.g. effacement of sulci, loss of gray–white junction). A dense middle cerebral artery may be visible.
- After 24 hours, infarct appears hypodense.
- A CT may be followed up with MRI and MR angiography.

Tuberculoma

Computed tomography appearances of brain tuberculoma are varied. They are

- Large, contrast-enhancing rings with central isodense areas (Fig. 11.56)
- Large, irregular nodular masses with intense contrast-induced enhancement

Both the above-mentioned appearances are highly suggestive of tuberculoma.

- Small discs (2–4 mm in diameter) with contrast enhancement and variable edema
- Small rings (6–8 mm in diameter) with contrast enhancement and variable edema

These appearances are seen with cysticercosis also.

Magnetic resonance imaging appearances vary depending upon the cellular component, fibrosis, gliosis and lipid content. Gadolinium enhancement may show ring enhancement.

Brain abscess (Fig. 11.57)

Computed tomography brain scan shows

- Lesion with low-density necrotic center
- Ring enhancement on contrast study

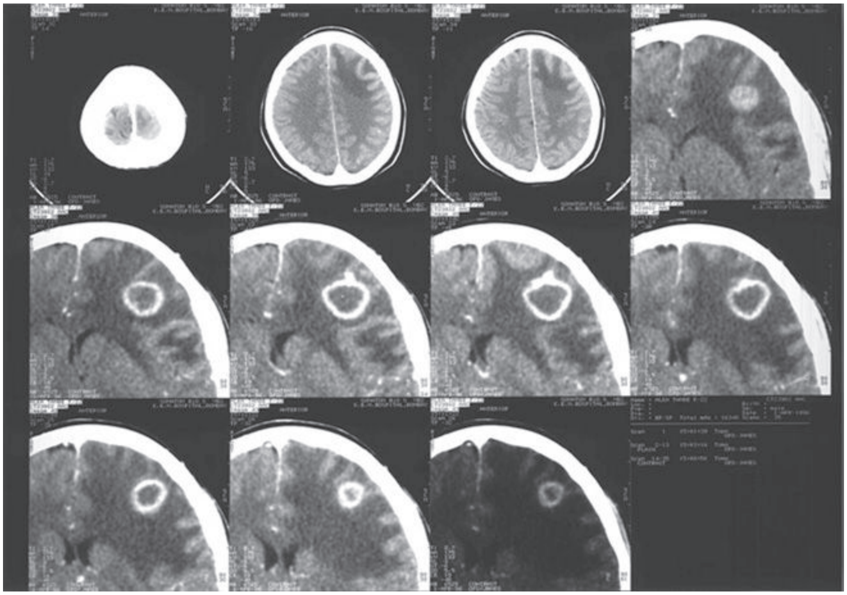

Figure 11.56 CT scan of brain-tuberculoma shows contrast-enhancing rings with central necrosis.

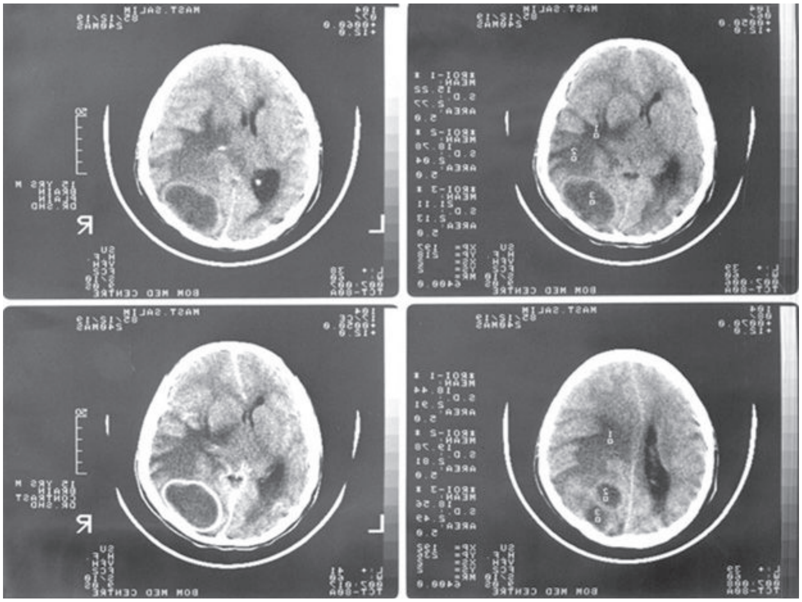

Figure 11.57 CT brain – Parietal lobe abscess with low-density enhancing capsule.

- Surrounding cerebral edema
- Opacification of mastoid sinuses may be seen (source of the infection)

Magnetic resonance imaging appearance is similar.

Neurocysticercosis (Figs. 11.38, 11.58)

Computed tomography scan of brain shows

- Multiple cystic or solid lesions of varying size
- Lesions that may be calcified or may exhibit contrast enhancement

- Calcified lesions that produce multiple punctuate lesions (Fig. 11.38)

Magnetic resonance imaging shows

- The cystic structure
- High-intensity ring around cysts on T1 images
- Gadolinium contrast enhancing lesions

Toxoplasmosis (Fig. 11.59)

Magnetic resonance imaging or double-dose contrast CT shows

- Single or multiple lesions at multiple locations
- Ring enhancement on contrast CT or MRI
- Surrounding edema

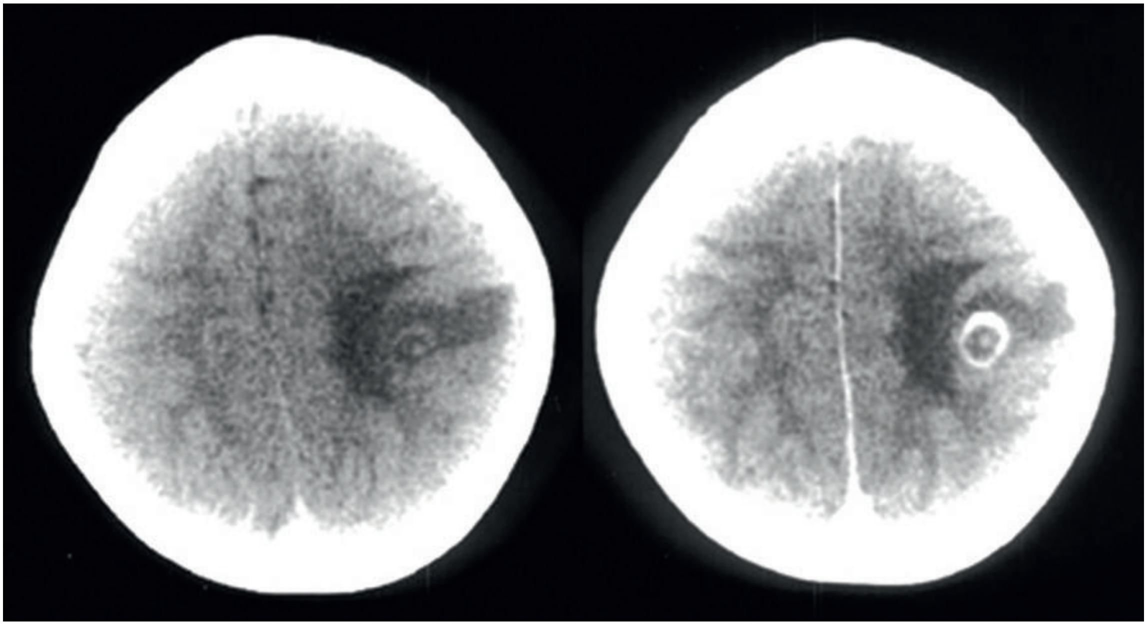

Figure 11.58 CT brain – Neurocysticercosis.

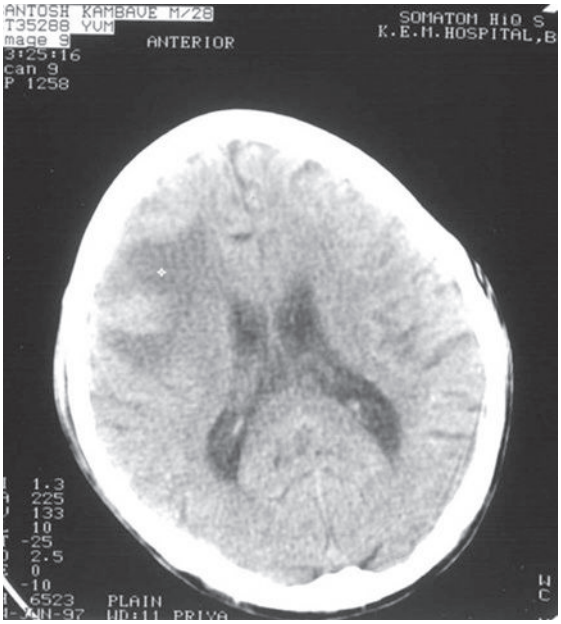
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Figure 11.59 CT brain – Toxoplasmosis.

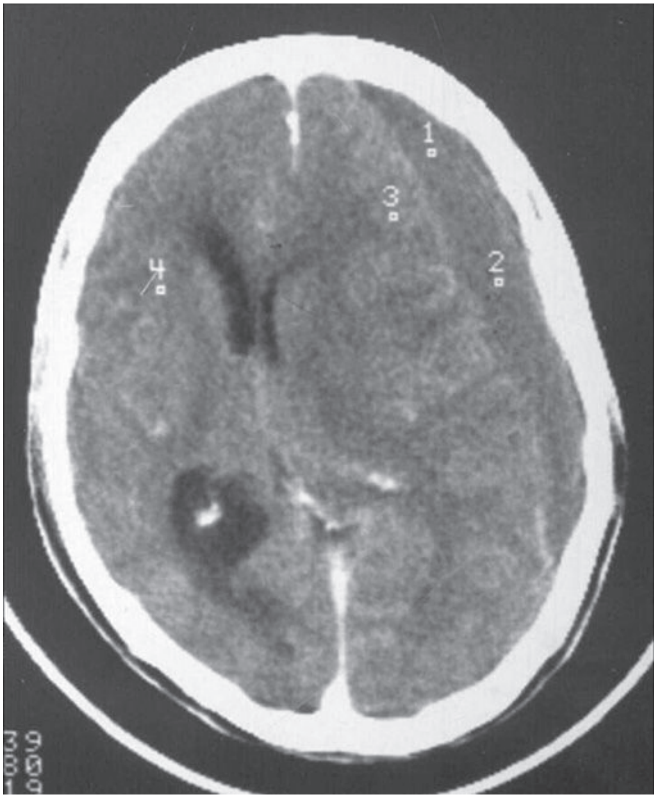

Figure 11.60 CT brain – Subdural hematoma.

Chronic subdural hematoma (Fig. 11.60)

- Computed tomography without contrast shows low-density mass over the convexity of cerebral hemisphere.
- Vascular fibrous capsule surrounding the clot is seen with contrast CT.
- Magnetic resonance imaging is also useful to diagnose subdural hematoma.

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Chapter 12

Procedures

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LUMBAR PUNCTURE (SPINAL TAP)

Lumbar puncture (LP) is indicated for diagnostic and therapeutic purposes. Lumbar puncture should be done only after proper clinical examination and evaluation of its benefits and hazards.

1. **Indications**
    - **a.** Diagnostic
        - **i.** Meningitis (bacterial, tuberculous, viral, fungal and carcinomatous)
        - **ii.** Neurosyphilis
        - **iii.** Subarachnoid hemorrhage (SAH), intracranial hemorrhage*
        - **iv.** Demyelinating disorders, e.g. multiple sclerosis
        - **v.** Guillain-Barré syndrome
        - **vi.** Contrast myelography*
        - **vii.** Pneumoencephalography*
        - **viii.** Cisternography*
        - **ix.** Queckenstedt's test*

*With the availability of CT and MRI, these indications are essentially obsolete. Lumbar puncture is indicated, only if SAH is strongly suspected and CT is –ve.

- **b.** Therapeutic
    - **i.** Drug administration
        - Methotrexate (leukemia)
        - Streptomycin TB meningitis (TBM)
        - Gentamicin (meningitis caused by Gram –ve organisms)
        - Crystalline penicillin (pyogenic meningitis)
    - **ii.** Relieve CSF pressure in normal pressure hydrocephalus

2. **Contraindications**
    - Raised intracranial pressure – Always check optic fundi for absence of papilledema before LP. Papilledema in the presence of a focal or mass lesion is an absolute contraindication because of danger of brain stem herniation. However, papilledema without CT evidence of a mass lesion is an indication for LP for diagnosis of pseudotumor cerebri and meningitis.

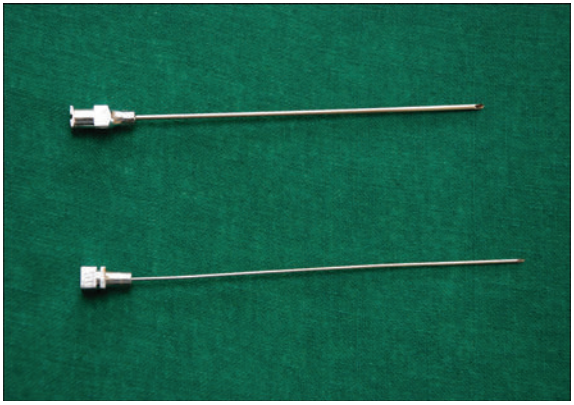

Figure 12.1 Lumbar puncture needle.

- Local infection
- Cord compression – LP can aggravate cord compression
- Marked spinal deformity
- Bleeding disorders (decreased platelets and patients on anticoagulants. These should be corrected before attempting LP)

3. **Lumbar puncture needle** – It is a 10–12 cm long BD needle, which has a stillete with a pin (Fig. 12.1). The stilette can be secured with the pin into a slot at the head end of the needle. Stilette prevents the lumen of the needle from getting blocked by skin tags during skin puncture.
4. **Procedure**
   - First, explain the procedure to the patient or a responsible person and obtain written, informed consent;
   - Make the patient lie at the edge of the bed in a fully flexed position with chin touching the knees;
   - Wash hands, wear a mask and glove the hands; (ideally wear a sterile gown);
   - Clean the back with tincture iodine;
   - Check the needle and manometer;
   - Identify 4th lumbar vertebra. It lies in the plane of the highest points of iliac crests. Lumbar puncture is done in the 3rd or 4th lumbar intervertebral space;
   - Anesthetize skin and deeper tissues up to ligamentum flavum with 1% lignocaine;
   - Insert the needle and direct it towards patient's umbilicus, keeping it parallel to bed. When the needle enters the subarachnoid space, a feeling of give way is felt;
   - Withdraw the stilette, measure CSF pressure and collect CSF in four (numbered) tubes (2–5 ml in each tube);
   - Withdraw the needle and apply local tincture benzoin seal;
   - Promptly send the fluid for biochemical, microbiological and cytological examinations;
   - Advise the patient to lie flat for at least 4 hours and to take plenty of oral fluids;
   - Watch the patient for neurological worsening. Check BP periodically.
5. **Complications**
   - Post-LP headache
   - Meningitis (iatrogenic)
   - Coning (with raised intracranial pressure)

   Post-LP headache
   - Usually begins within 4 hours
   - Brought on by sitting or standing
   - Usually occipito frontal
   - May be associated with nausea, neck stiffness and occasionally blurred vision, photophobia, tinnitus and vertigo
   - Treatment – Lying flat in bed, intravenous saline or epidural blood patch
6. **Problems**
   - Dry tap – It can be due to improper placement of needle (common cause) or spinal cord compression with spinal block.
   - Bloody tap – It is due to injury to meningeal vessels. It can be confused with SAH. Differences are (a) on immediately centrifuging CSF, with bloody tap, the supernatant CSF is clear. Xanthochromic supernatant CSF is seen in SAH; (b) blood clears in successive tubes in traumatic bloody tap.

   Note – Xanthochromic CSF is also a feature of high protein content (greater than 1.5–2.0 g/L) and liver disease (jaundice).

   Causes of high CSF protein – Meningitis, Guillain-Barré syndrome, spinal block, multiple sclerosis, acoustic neuroma, hypothyroidism, diabetes mellitus.

CISTERNAL PUNCTURE

1. **Indications**
   - Cisternal puncture is carried out for diagnostic purposes to collect CSF for examination when LP is not possible due to

  severe deformity, local infective pathology or traumatic tap.
  - Earlier, cisternal puncture was done to perform descending myelogram to determine the upper limit of spinal subarachnoid block. This has been superseded by modern imaging modalities and is hardly practiced now.
2. **Contraindications** for cisternal puncture are same as for LP.
3. **Procedure**
   - Consent and aseptic precautions are same as for LP.
   - The puncture site is prepared by shaving the back of the head from occiput down.
   - The procedure is performed with the patient lying on his side, near the edge of the bed.
   - The puncture site is in the midline, approximately ½ inch above the 2nd cervical vertebra.
   - Calibrated LP needle with a short bevel with the stilette in place is introduced and pushed forward in the plane of tragus and nasion. The cisternal space is approximately 4–5 cm deep. When entered, CSF flows out.
   - Cerebrospinal fluid is collected as described under LP. The needle is withdrawn and the puncture site is sealed with tincture benzoin.
   - Postprocedure management is same as for LP.
   - Complications and their management are same as for LP.

LIVER BIOPSY

The purpose of performing liver biopsy is to obtain histopathologic and other information, which cannot be obtained otherwise.

1. **Indications**
   - Diagnosis of cirrhosis of liver
   - Diagnosis and staging of alcoholic liver disease, nonalcoholic steatosis and chronic hepatitis
   - Unexplained, persistent abnormalities of liver enzymes to identify and evaluate underlying pathology
   - Unexplained jaundice
   - Unexplained hepatosplenomegaly
   - Fever of unknown origin
   - Suspected malignancy of liver (e.g. hepatoma, lymphoma)
   - Unexplained systemic illness
   - Diagnosis of granulomatous liver disease (tuberculosis, sarcoidosis, schistosomiasis)
2. **Contraindications**
   - Uncooperative patient, inability of the patient to hold breath
   - Hepatic encephalopathy
   - Bleeding diathesis (international normalized ratio [INR] greater than 1.2, prothrombin time [PT] greater than 4 s, bleeding time greater than 10 min, platelet count less than 50,000/mm^3)
   - Gross ascites
   - Right-side heart failure
   - Suspected hemangioma of the liver
   - Severe anemia
   - Peritonitis
   - Subphrenic or right pleural effusion, infection
   - Extrahepatic biliary obstruction
   - Suspected hydatid cyst
   - Suspected vascular lesion

The liver tissue obtained is subjected to cytology, histopathology, frozen section and culture examination. Copper and iron contents are measured respectively if Wilson's disease or hemochromatosis are suspected.

Limitations of liver biopsy – Sampling error, inadequate tissue

3. **Biopsy procedure**
   a. Precautions before performing biopsy
      - Exclude bleeding tendency. Correct coagulopathy with vitamin K injections or if necessary with fresh frozen plasma. For thrombocytopenia, provide cover with platelet transfusions.
      - Keep blood available after grouping and cross matching
      - Drain ascites if present

   b. Procedure
      - Explain the patient or a responsible person the procedure and obtain written informed consent.
      - Biopsy is performed with patient lying in bed in supine position.
      - Observe all aseptic precautions (as described for LP).
      - Biopsy site is 9th or 10th intercostal space (ICS) in the midaxillary line (transpleural approach; alternative route is subcostal when there is hepatomegaly).
      - Infiltrate skin and subcutaneous tissues up to the liver capsule with local

  anesthetic (1–2% lignocaine), inject as the needle is withdrawn.
- Use either Vim-Silverman's or preferably Menghini's needle.

Vim-Silverman needle – The needle consists of a trocar, canula and a bifid needle (Fig. 12.2A).

- Push the needle along with trocar into the liver substance (when the needle moves up and down with respiration), ask the patient to hold his breath.
Withdraw the trocar, and insert and push in the bifid needle fully (it protrudes beyond the tip of the canula).
Push the canula over the needle, and withdraw the canula and the needle together, and then allow the patient to breathe.
- Apply local tincture benzoin seal.
- Advise the patient to take rest for 4–6 hours and check pulse and BP.
- Place the liver tissue obtained in a bottle containing Bouin's fluid.

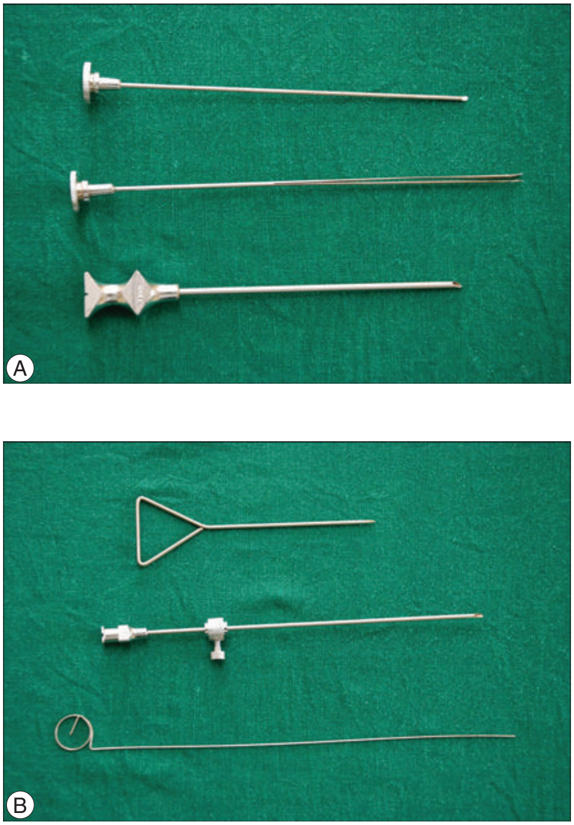

Figure 12.2 (A) Vim-Silverman liver biopsy needle. (B) Menghini liver biopsy needle.

Menghini needle

- It is a needle with an attached syringe (Fig. 12.2B)
- Follow initial steps as described in Vim-Silverman method*
- Fill the syringe with 3 ml sterile saline
Insert the needle into the ICS and flush it with 2 ml saline
With patient holding his breath, quickly push the needle into liver substance and withdraw, simultaneously applying negative pressure to the syringe
Place needle tip in a receptacle containing saline
- Apply local tincture benzoin seal
- Send the tissue obtained for examination
- Monitor patient for 4–6 hours

*Ultrasound (US)-guided biopsy is preferred

4. **Complications**
   - Intra-abdominal bleeding
   - Hepatic encephalopathy
   - Biliary peritonitis
   - Injury to intra-abdominal structures/organs
   - Liver laceration
5. **Failure to obtain liver tissue** – Causes are
   - Faulty technique
   - Gross ascites
   - Tough (cirrhotic) liver

Transjugular venous biopsy of liver is performed in patients with severe coagulopathy.

PLEURAL FLUID ASPIRATION (THORACENTESIS)

Thoracentesis is a procedure to aspirate pleural fluid by puncturing the chest wall. The procedure has diagnostic and therapeutic indications.

1. **Indications**
   - a. Diagnostic – To determine the etiology of pleural fluid
   - b. Therapeutic
     - i. To relieve cardiorespiratory distress due to a large effusion
     - ii. Pleurodesis
2. **Contraindications**
   - No absolute contraindications, relative contraindications are –
   - Very small effusion
   - Bleeding diathesis
   - Uncontrolled cough

3. **Procedure**
   - Explain the procedure to the patient and obtain written, informed consent.
   - Observe aseptic precautions as described under LP.
   - Thoracentesis is usually performed with the patient in a sitting position and leaning forward on an arm rest (bed table). (In patients on ventilator, thoracentesis can be performed in supine position, when it is best done under ultrasound guidance [USG].)
   - Inject 0.6 mg of atropine as preanesthetic medication, half an hour before the procedure.
   - Aspiration site is usually 7th or 8th ICS in midaxillary or scapular line.
   - Infiltrate skin, subcutaneous tissues and parietal pleura with local anesthetic (lignocaine 1–2%). Parietal pleura is very sensitive to pain and should be well infiltrated.
   - Introduce a large bore aspiration needle (16–19 gauge; Fig. 12.3) near the upper border of lower rib (to avoid injury to intercostal nerve and vessels), and push it with intermittent suction until it enters the pleural space and a feeling of give way is felt. Aspirate pleural fluid with a 50 ml syringe attached to a two-way or three-way stopcock and a draining tube.
   - At the end of the procedure, seal the puncture site with tincture benzoin.
   - Advise the patient to rest for 4 hours and observe vitals.
   - For pain, prescribe simple analgesics.
   - The amount of fluid removed depends upon whether it is a diagnostic or a therapeutic thoracentesis. In any case, do not aspirate more than 1.5 l (preferably 1000 ml) of fluid in one sitting. (This volume is enough to relieve cardiopulmonary distress.) Stop aspiration if patient complains of cough (a symptom of pulmonary edema) or a feeling of tightness in the chest.
   - A routine postprocedure chest X-ray may be taken (to rule out pneumothorax, to evaluate amount of fluid remaining in the pleural cavity and to get a better view of the now 'exposed' lung fields). If necessary, thoracentesis can be repeated after 12 hours.

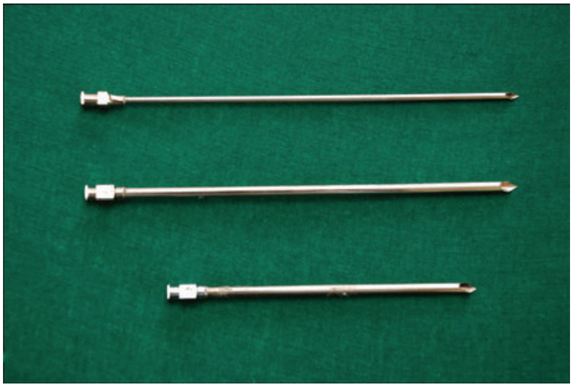

Figure 12.3 Aspiration needles.

4. **Complications**
   - Injury to subcostal nerve and blood vessels, or the lung (with development of hemothorax* or hemoptysis)
   - Vasovagal syncope (pleural shock)
   - Introduction of infection
   - Subcutaneous emphysema
   - Pneumothorax
   - Air embolism
   - Postthoracentesis pleural pain (pleural rub may appear)
   - Pulmonary edema (if large volume of fluid is removed)
   - Hypotension (if large volume of fluid is removed)
   - Liver or spleen injury

*Bloody fluid, secondary to trauma to vessels during thoracentesis clots on standing, which is not the case with true hemothorax.

Send the fluid for biochemical analysis, microscopy, cytology, and culture as indicated.

PNEUMOTHORAX ASPIRATION

1. **Indications**
   - Large pneumothorax (greater than 20% as it is unlikely to resolve spontaneously)
   - Tension pneumothorax
2. **Procedure**
   - Explain the procedure and obtain written informed consent.
   - Follow aseptic precautions.
   - Infiltrate skin and subcutaneous tissue in the 2nd intercostal space in the midclavicular line with 1–2% lignocaine.
   - Make a small incision in the skin.

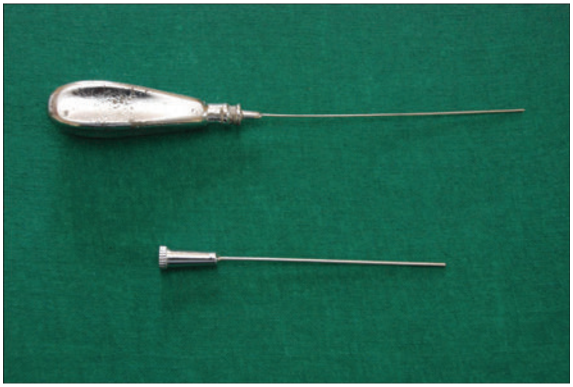

Figure 12.4 Trocar and canula.

- Insert trocar with canula (Fig. 12.4) in the pleural space, keeping the trocar close to the upper border of the lower rib.
- Introduce a small rubber or pigtail catheter through the canula into the pleural space and connect it to an underwater seal. Alternatively, connect the catheter to a three-way stopcock and with a syringe aspirate the air and expel it out.
- Continue drainage/aspiration until the lung expands or 4 l of air is removed.
- Remove the catheter if the lung expands, else connect it to an underwater seal or attach the catheter to a one-way Heimlich valve that permits ambulation.

3. **Complications**
    - Re-expansion pulmonary edema*
    - Injury to subcostal nerve and vessels
    - Air leak with subcutaneous emphysema
    - Introduction of infection

*Develops if lung reexpands rapidly or the lung has been collapsed for more than 48 hours. Treatment includes cardiopulmonary support including oxygen and diuretics.

4. **Special problems**
    a. Failure of lung to expand. Causes are
        i. Persistence of air leak*
        ii. Malposition of tube
        iii. Trapped lung*
        iv. Endobronchial obstruction

*These may need thoracoscopy or thoracotomy

5. **Tension pneumothorax** – This is a medical emergency and is treated by inserting a needle of 14–16 gauge into the 2nd ICS in midclavicular line. The air leaks out with a hissing sound, which confirms the diagnosis of tension pneumothorax and provides relief to the patient. Further management is as described for pneumothorax.

PERICARDIOCENTESIS

Pericardiocentesis is a potentially risky procedure. It should ideally be performed under ultrasonography guidance with ECG monitoring. It is a good policy to have a thoracic surgeon or a cardiologist to supervise the procedure. Pericardiocentesis can be performed by needle aspiration or by surgical drainage.

1. **Indications**
    - To diagnose the cause of pericardial effusion
    - Therapeutic
    - Relieve cardiac tamponade
    - Persistent pericardial effusion
    - Rapidly progressive pericardial effusion
2. **Procedure**
    - Explain the procedure, obtain written informed consent
    - Give atropine (0.6 mg) and morphine or midazolam as premedication
    - The most favored site of puncture is the angle between xiphisternum and costal margin; alternate sites are transthoracic usually in the 5th ICS, inside the outer border of cardiac dullness but outside the cardiac apex; posteriorly below the inferior angle of scapula and 4th ICS, lateral to the sternum
    - The procedure is carried out under USG with the patient lying supine in bed and 30° propped up position
    - Observe all aseptic precautions (see LP)
    - Infiltrate skin and subcutaneous tissues with 1% lignocaine
    - Introduce, under USG, a short-beveled needle (16 gauge, 75 mm long) attached to a syringe in the xiphisternal angle, at an angle of 45°, and push it upwards toward the midclavicular line until pericardium is penetrated
    - All along, apply negative pressure to the syringe and monitor with electrocardiography (ECG) to detect arrhythmias (due to the needle touching or penetrating the myocardium)

- Secure the needle to the chest wall and aspirate the fluid
- If continuous drainage is necessary, pass a catheter through the needle and leave it in place
- Withdraw the needle and seal the puncture site with tincture benzoin
- Monitor patient's vitals for 4 hours postprocedure
- Prescribe simple analgesics to relieve pain
- Send the fluid promptly for biochemical, microbiology and cytology examinations

3. **Complications**
   - Myocardial injury (± penetration)
   - Injury to coronary arteries (both cardiac muscle injury and coronary arteries injury lead to hemopericardium)
   - Cardiac arrhythmias
   - Shock

ABDOMINAL PARACENTESIS (ASCITIC TAPPING)

1. **Indications**
   - **a.** Diagnostic – To diagnose transudate, exudate, infection, malignancy, spontaneous bacterial peritonitis
   - **b.** Therapeutic
     - Tense or large ascites causing discomfort or cardiorespiratory embarrassment
     - Ascites not responding to medical treatment
2. **Contraindications**
   - **a.** Absolute contraindications
     - Hepatic encephalopathy
     - Severe jaundice
     - Severe uncorrectable clotting disorder
     - Intestinal obstruction
     - Infected abdominal wall
   - **b.** Relative contraindications
     - Uncooperative patient
     - Severe portal hypertension
3. **Precautions** – Patient's urinary bladder must be empty
4. **Procedure**
   - Explain the procedure, obtain written informed consent
   - Sedation (mild) may be used (avoid in patient with hepatocellular failure)
   - Observe all aseptic precautions
   - For paracentesis patient can be in supine or semirecumbent position, position that is comfortable to the patient
   - Usual site of puncture – Midway between anterior superior iliac spine and umbilicus
   - With proper aseptic precautions, local preparation and local anesthesia, introduce a large bore needle attached to a 50-ml syringe. For diagnostic aspiration, collect fluid in test tubes for examination
   - For therapeutic paracentesis – Attach the needle to a catheter and allow ascites to drain slowly
   - Postprocedure, an abdominal binder may be applied. Send the fluid for laboratory testing as for pleural fluid. If spontaneous bacterial peritonitis is suspected the culture bottle should be inoculated at the bed-side. Additional tests may include estimation of amylase and triglycerides
   - Up to 4 liters of ascitic fluid can be drained in a day but needs concomitant infusion of salt-free albumin to prevent development of hypovolemia
5. **Complications**
   - Hepatic encephalopathy
   - Damage to internal organs
   - Secondary infection
   - Protein loss
   - Hemorrhage
   - Prolonged ascitic fluid leakage

BONE MARROW EXAMINATION

Bone marrow can be obtained for examination by aspiration, closed-needle biopsy or open surgical biopsy. Bone marrow biopsy is necessary if adequate bone marrow is not obtained by aspiration.

1. **Indications**
   - **a.** Cytopenias
     - Abnormal cell morphology in peripheral smear
     - Suspected multiple myeloma
     - Diagnosis and classification of leukemias
     - Staging of lymphoma
     - Assess response to therapy of leukemia, lymphoma
     - Unexplained splenomegaly or lymphadenopathy

  - Unexplained fever, leukocytosis, thrombocytosis
  - Bone marrow transplant

Note: Hypochromic anemia (due to pure iron deficiency [see below], chronic inflammation or thalassemia) by itself is not an indication for bone marrow examination.

2. **Diseases that can be diagnosed on bone marrow examination**
   - Megaloblastic anemia
   - Iron deficiency (not advised routinely). May be done to assess iron stores
   - Aleukemic leukemia
   - Aplastic anemia
   - Myelofibrosis
   - Multiple myeloma
   - Kala-azar, malaria
   - Secondaries
   - Infiltrative disorders like Gaucher's disease
   - Myelodysplastic syndrome
   - Sideroblastic anemia
   - Pure red-cell aplasia
   - B-19 parvovirus infection
   - Mast cell disease
   - Idiopathic thrombocytopenic purpura
   - Thrombotic thrombocytopenic purpura
   - Cytogenetic and molecular analysis in hemopoietic malignancies and congenital lesions of RBC precursors (e.g. Fanconi's anemia)
3. **Contraindications** – Thrombocytopenia is not a contraindication, but clotting disorder like hemophilia is a contraindication.
4. **Procedure**
   a. Explain the procedure and obtain written informed consent
      - Various types of needles are used for bone marrow aspiration. Figures 12.5A and 12.5B show two commonly used needles. Sahli's needle has a guard to prevent over penetration.
      - The most common bone marrow aspiration site is posterior iliac spine. Alternative sites are iliac crest and manubrium sterni. In children, less than 1 year of age, anterior surface of tibia can be used. Spinous process of lumbar vertebra is rarely used.
      - Observing usual aseptic precautions, infiltrate the site up to the periosteum with 1–2% lignocaine.
      - Push the needle (with the stilette in and the guard fixed approximately 1 inch from the tip) with boring motions into the bone till it enters the bone marrow, which is felt as diminished resistance.

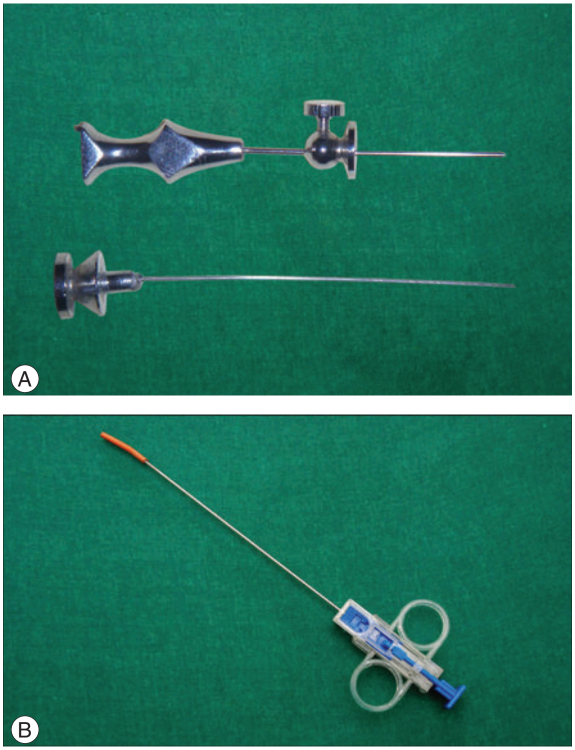

Figure 12.5 (A) Sahli bone marrow needle. (B) Bone marrow aspiration needle (disposable).

      - Withdraw the stilette and aspirate bone marrow (0.2–0.5 ml) in a 1-ml syringe attached to the aspiration needle. Not more than 0.5 ml should be aspirated to avoid dilution with blood. Aspiration of bone marrow can cause excruciating pain.
      - Withdraw the needle and prepare bone marrow slides. Presence of bone marrow particles confirms adequate bone marrow aspiration (absence of particles indicates that only blood has been aspirated).
      - Seal the aspiration site with tincture benzoin after applying pressure for a few minutes (to ensure hemostasis). Observe the patient for 4 hours. Treat pain with simple analgesics.
5. **Complications**
   - Local pain
   - Local bleeding
   - Local infection

- If sternal site is used, manubrium can be penetrated through with injury to large vessels and pericardium (likely to happen with very soft bones)

6. Problems

a. Dry tap. Causes are
  - Faulty technique
  - Hyperplastic bone marrow (leukemia)
  - Aleukemic leukemia
  - Myelofibrosis
  - Aplastic bone marrow
  - Carcinomatous infiltration of bone marrow

b. It may not be possible to penetrate the bone in patients with marble bone disease.

7. Bone marrow biopsy

- It can be performed along with marrow aspiration.
- Jamshedji Swain needle or Islam needle is used.
- Make the patient lie in the left or right lateral position at the edge of the bed with back flexed comfortably.
- The site of biopsy is posterior iliac spine.
- Steps of preparation are similar to that of marrow aspiration.
- Make a small incision over the iliac crest.
- Introduce the needle with the stylet in place and with boring motions push it forward in the direction of anterior superior iliac spine, till a decrease in resistance is felt (indicates needle has entered marrow cavity).
- Remove the stylet and advance the needle for 2–3 cm., shift the needle tip 2–3 mm and rotate it clockwise–anticlockwise to detach the marrow.
- Quickly remove the needle and apply pressure for 10–15 minutes at the puncture site.
- Prepare smears and place the marrow specimen in acidic Zenker's solution for further processing.

URINARY BLADDER CATHETERIZATION

1. Indications

a. Diagnostic
  - To obtain urine for examination
  - To measure residual urine volume
  - For contrast introduction

b. Therapeutic
  - Retention of urine
  - Bladder irrigation
  - Local drug delivery (e.g. amphotericin for fungal infection of bladder)

2. Contraindications – Recurrent UTI

3. Catheters

All catheters have ports at the tip to drain urine.

a. Sizes
  - Adults – 14–24 F units (1 F unit = 0.33 mm)
  - Children 8–12 F units
  - Smaller size catheters are used for patients with urethral strictures and bladder neck obstruction
  - Larger size catheters are used for post-operative bladder irrigation, bladder hemorrhage and pyuria

b. Types
  - Straight-tip for intermittent catheterization
  - Bent tip for urethral stricture or bladder neck obstruction
  - Malecot urinary catheter (Fig. 12.6A). Self-retaining, e.g. Foley catheter (Fig. 12.6B) has an inflatable balloon for self-retention

c. Balloon volumes
  - Children – 2.5–5.0 ml
  - Adults – 10–30 ml
  - Larger balloon catheters are indicated for treatment of vesical bleeding

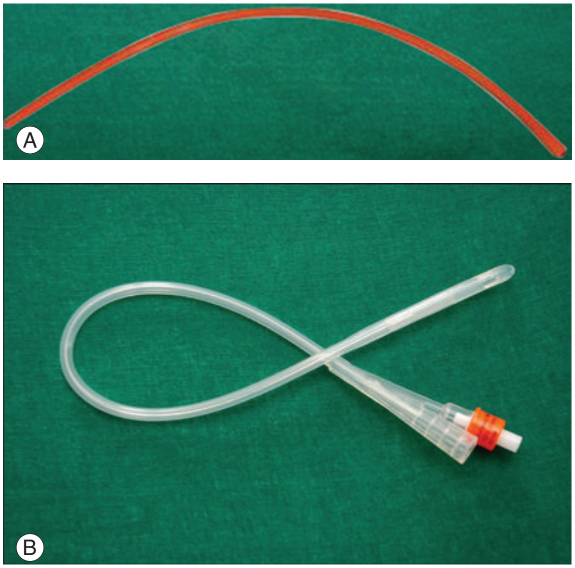

Figure 12.6 (A) Malecot rubber catheter. (B) Foley urinary catheter.

d. Materials
  - Latex, polyvinyl chloride or plastic catheters for intermittent drainage
  - For continuous catheterization – Latex with silicone, hydrogel or polymer catheters
  - For patients with latex allergy – Silicone catheters

4. Technique

a. Urethral catheterization
  - Clean urethral meatus carefully with an antibacterial solution (lignocaine jelly may be applied locally and injected into urethra).
  - Lubricate catheter with a sterile gel.
  - Introduce catheter through urethral meatus and push it gently till it enters the bladder (stylets can be used to facilitate catheterization, especially in the presence of stricture or obstruction and in children).

5. Complications
- Trauma to urethra and bladder
- Creation of false passage
- Bladder perforation
- Hemorrhage (if bladder is emptied rapidly)

b. Suprapubic catheterization (via percutaneous cystostomy). Indications are:
- Post bladder and urethral surgeries
- Long term bladder drainage

For prolonged catheterization, additional measures to be observed are:
- Apply a spigot to the catheter
- Secure the catheter
- Daily bladder washes
- Ensure good (high) urine output
- Alkalinize urine

Modern catheters can be changed once in 2–3 weeks. Patients with neurogenic bladder are trained to perform (intermittent) self-catheterization.

NASOGASTRIC INTUBATION

1. Indications
- Feeding unconscious patients, critically ill patients and patients with bulbar palsy
- Gastric lavage for removal of poison
- Intestinal obstruction to relieve abdominal distension
- Obtaining gastric juice for examination

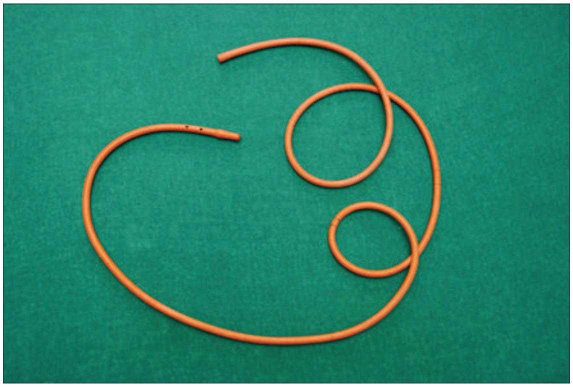

Figure 12.7 Ryle's tube.

2. Tubes
- Ryle's tube (Fig. 12.7)
- Levine tube

3. Technique
- Check patency of the tube
- Lubricate the tip with liquid paraffin
- Examine patient's nose for deviated nasal septum, obstruction, discharge and select the side for tube insertion
- Introduce the tube via nostril and push gently with the patient taking deep breaths (this avoids retching) along the floor of nose and pharynx
- Push the tube to enter the esophagus (ask the patient to swallow sips of water or do swallowing movements to help esophageal entry)
- Confirm intragastric position of the tube by aspirating gastric contents. Also auscultate over stomach while injecting air in the tube
- Tape the tube over the forehead

4. Problems
- Coiling of the tube in oropharynx
- Tube may enter trachea. Patient starts coughing and there is blow of air with breathing at the open end of the tube

5. Complications
- Rhinitis
- Pharyngitis
- Esophageal ulceration

- Intratracheal placement of the tube when feeding leads to aspiration pneumonia and even death

ENEMA

Enema is the procedure of introducing (injecting) liquid into the rectum

1. **Types of enemas** – Evacuant enema (to treat constipation), retention enema
    - **a.** Evacuant enema fluids
        - 500 ml warm water (water at 37 °C)
        - Glycerine (2–4 drachms glycerine + equal volume of water)
        - Saponin enema (15 ml of green soap dissolved in 500 ml of water at 37 °C)
        - Olive oil (5–10 fl oz at 37 °C)
        - Castor oil (1–2 fl oz of castor oil well mixed in 2–4 fl oz olive oil)
        - Turpentine (½ fl oz turpentine mixed with starch or soap + water – 15 fl oz for adult)
        - Phosphate (60 ml)
    - **b.** Retention enemas

Enema	Indication	Dose
Starch opium enema	Pain relief; excessive diarrhea	10–40 minims opium + 3 gm starch paste in 60 ml water
Normal saline enema	Shock or dehydration	2–3 l of N saline/day
Astringent enema	Dysentery, ulcerative colitis	Silver nitrate (1:5000 increased to 1:500) + 3% tannic acid or 3% alum

Retention enemas can be used to introduce drugs (chloral hydrate, paraldehyde, antibiotics, and magnesium sulfate) or predigested food. Barium enema is used for diagnostic purposes. Magnesium sulfate enema is used to reduce intracranial pressure.

2. **Procedure**
    - Ask the patient to lie in left lateral position at the edge of bed with flexed knees
    - Raise the foot end of bed
    - Check temperature of enema fluid
    - Lubricate the tip of catheter
    - Nip catheter tip and introduce the catheter for 8–10 cm in rectum with the help of finger kept on anus
    - Raise the enema can one foot above the patient level to allow enema fluid to flow in
    - Withdraw the catheter at the end
    - Provide bed pan when asked for
    - Note the enema result
    - Clean the catheter, flush and boil it for 5 minutes
3. **Complications**
    - Common to all enemas – Mechanical trauma
    - Olive oil enema – Fecal incontinence
    - Phosphate enema – Hyperphosphatemia

ENDOTRACHEAL INTUBATION

1. **Indications**
    - Patients needing ventilatory support
    - Unconscious patients, before performing gastric lavage
    - Poor cough reflex with accumulation of secretions
2. **Tubes**
    - **a.** Large-size (greater than 8 mm internal diameter) endotracheal tubes with high-volume and low-pressure balloon cuffs (Fig. 12.8) are usually used in adults and in children above 8 years of age.
    - **b.** Advantages of larger tubes
        - Offer lower resistance to air flow

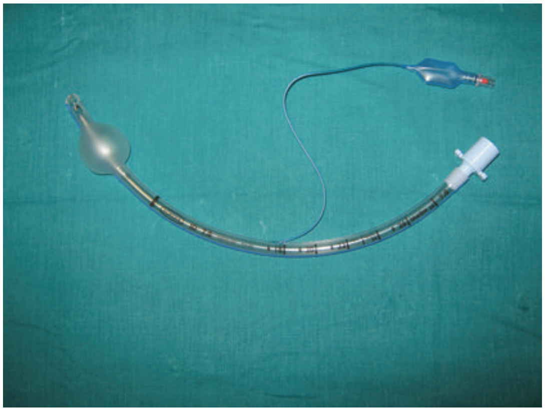

Figure 12.8 Portex endotracheal tube.

  - Permit suction of secretions
  - Permit passage of bronchoscope
3. **Technique**
   - Use orotracheal route in critically ill or apneic patients
   - Nasotracheal intubation preferred in conscious patients
   - Check the balloon cuff for symmetric expansion and leak
   - Use local lignocaine spray in conscious patients (muscle relaxants, sedation and vagolytic agents can be used). Lubricate the endotracheal tube (with or without a stylet in situ)
   - Visualize the glottis and vocal cords with a laryngoscope (essential to avoid esophageal intubation), use the oral or nasal route to push the tube through vocal cords to enter the trachea
   - Remove the stylet and inflate the balloon
   - Insert a bite block in the mouth and secure the tube by taping it to the corner of mouth and upper lip
   - Check proper positioning of the tube by the presence of good breath sounds on both sides of chest and absence of gurgling sounds over upper abdomen; take an X-ray of chest to confirm tracheal position of the tube
4. **Problems**
   - Esophageal intubation. In such a situation, insert another tube immediately in the trachea (to avoid aspiration of gastric secretions) and pull out the esophageal tube
   - Too low tube placement with blocking of one of the main bronchus (usually left). Deflate the cuff and gently pull back the tube 1–2 cm; recheck proper position of the tube by auscultating over both sides of the chest
5. **Complications**
   - Trauma to lips, teeth, tongue, supraglottic and infraglottic areas
   - Esophageal intubation; causes gastric distension and aspiration; can result in death
   - Injury to vocal cords with ulceration, ischemia and cord paralysis, which can persist for a long time
   - Subglottic stenosis
   - Pressure necrosis of trachea, fistula formation, major vessel bleeding and tracheal stenosis (avoided by periodic checking of balloon pressure and intermittently releasing the pressure)
   - Unilateral lung collapse due to low placement of the endotracheal tube

BRONCHOSCOPY

Bronchoscopy is the procedure of introduction of bronchoscope into the airways for direct visualization of bronchial tree. Two types of bronchoscopes are available: rigid and flexible. Fiberoptic flexible bronchoscope is 4.5–6.5 mm in diameter (Fig. 12.9). Rigid bronchoscopes are larger in diameter. Flexible bronchoscopy can be performed as an outpatient procedure. It can visualize airways up to subsegmental bronchi.

1. **Applications of bronchoscopy**
   - a. Flexible bronchoscopy
     - Obtaining bronchial secretions and cells by bronchial washings, bronchial brushing or bronchoalveolar washings
     - Biopsies of endobronchial, parenchymal and mediastinal structures
     - Removal of retained secretions, foreign bodies and carrying out endoscopic procedures (e.g. stenting)
   - b. Rigid bronchoscopy
     - Rigid bronchoscopy is preferred in the presence of active, profuse pulmonary hemorrhage. Rigid bronchoscope permits better visualization of bleeding source and more efficient suction of blood, thus preventing asphyxiation.

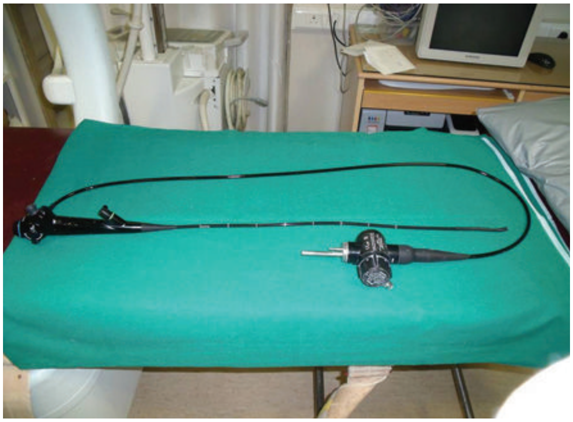

Figure 12.9 Fiberoptic bronchoscope.

    - Removal of foreign body in young children
    - Laser debulking of endobronchial lesions
    - Stenting

2. **Contraindications**
   - **a.** Absolute
     - Unstable cardiac status
     - Acute respiratory failure with hypercapnia (unless patient is intubated and ventilated)
     - Inadequate oxygenation
   - **b.** Relative
     - Uncooperative patient
     - Coagulopathy that cannot be corrected
     - High-grade tracheal obstruction
     - Transbronchial biopsy in patients with uremia, pulmonary hypertension and superior vena caval obstruction
3. **Procedure**
   - Patient should be fasting for at least 4 hours before the procedure
   - Oxygen, IV access, pulse oximetry, cardiac monitoring are necessary
   - Premedicate with atropine 0.6–1.2 mg (IM or IV) ± sedation with benzodiazepine, codeine or morphine (to allay anxiety and to reduce cough, secretions and vagal tone) Anesthetize pharynx and vocal cords with 1 or 2% lidocaine (nebulized or aerosolized)
   - Introduce bronchoscope (lubricated with lidocaine jelly) through the nostril or mouth and negotiate it through the vocal cords during inspiration, into the trachea and upper airways
   - Carry out the intended procedure (aspiration, biopsy, alveolar lavage, etc.)
   - Post procedure, observe vitals for 2–4 hours; continue O_2 supplementation until gag reflex returns, and O_2 saturation is maintained unaided
   - Obtain X-ray of chest in expiration if a biopsy is performed (to detect pneumothorax)
4. **Complications**
   - Bleeding, pneumothorax
   - Oversedation with respiratory depression, and hypoxemia
   - Hypotension, cardiac arrhythmias, cardiac arrest
   - Laryngospasm, bronchospasm, laryngeal edema, vocal cord injury
   - Seizures
   - Infection
   - Death

PLEURAL BIOPSY

Pleural biopsy is indicated when the etiology of an exudative pleural effusion is not clear. With modern diagnostic facilities/techniques, like video-assisted thoracic surgery (VATS), adenosine deaminase estimation, PCR for tuberculosis, etc.), the need or indications for needle biopsy of pleura have diminished significantly.

Abrams (Fig. 12.10) or Cope's (Fig. 12.11) needle can be used. Pleural biopsy is highly useful for the diagnosis of tuberculosis and malignancy.

The technique is essentially similar to thoracocentesis except that a small skin incision is necessary to allow the biopsy needle to be introduced. After the introduction of the needle with trocar in position, the latter is removed and the notch at the tip of the needle is anchored against the pleura. The trocar is removed and the cutting needle is introduced to obtain the pleural biopsy, which remains lodged in the notch. The needle is rotated and placed in 2–3 different positions and multiple

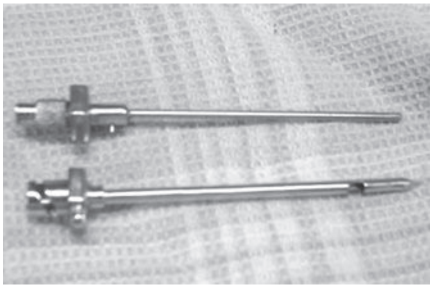

Figure 12.10 Abrams pleural biopsy needle.

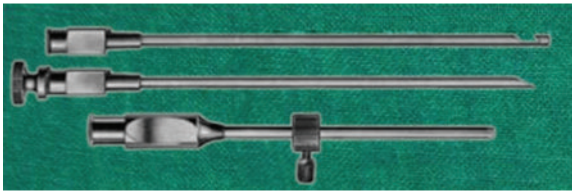

Figure 12.11 Cope's pleural biopsy needle.

biopsies obtained to improve the diagnostic yield. The needle is removed, wound sealed, and the biopsy pieces are sent for histopathology and microbiology examinations.

Complications and treatment are similar to thoracocentesis.

RENAL BIOPSY (KIDNEY BIOPSY)

Renal biopsy is a useful procedure to obtain diagnostic or prognostic information, to direct or evaluate treatment and as a part of clinical trial.

1. **Indications**
    - a. Suspected glomerular disease
        - Asymptomatic proteinuria
        - Persistent or recurrent hematuria of undetermined cause (after extensive evaluation)
        - Acute renal failure when acute glomerulonephritis or allergic nephritis is suspected and obstructive uropathy is excluded
        - Posttransplant to diagnose rejection
    - b. Prognostic
      To assess degree of glomerular sclerosis and interstitial fibrosis
2. **Contraindications**
    - Severe hypertension (diastolic pressure greater than 110 mm Hg)
    - Uncooperative patient
    - Uncorrectable bleeding diathesis
    - Unilateral kidney
    - Suspected infection (perinephric abscess, pyonephrosis)
    - Small kidneys
    - Hydronephrosis
    - Polycystic kidney disease or large solitary cyst
    - Hypernephroma
    - Pregnancy
    - Obesity
3. **Prebiopsy screening tests**
    - Complete blood counts including platelet count
    - Prothrombin time
    - Partial thromboplastin time
    - Bleeding time
    - Ultrasound of kidneys to exclude small kidneys, unilateral kidney, etc. and to locate kidney position: If US is not available, intravenous pyelogram [IVP] or even a good plain X-ray of abdomen can serve the purpose
    - One unit of grouped and cross-matched blood should be available
4. **Procedure**

Tru-cut disposable needle is used (Fig. 12.12). It is a single piece, 11.5-cm long needle with an obturator. Larger 15-cm needle is available for obese and large individuals.

- The procedure is explained and informed consent obtained.
- All aseptic precautions are observed.
- Premedication with diazepam is given.
- The biopsy is performed with the patient lying in prone position with a pillow under his abdomen.
- Biopsy is (ideally) carried out under US or fluroscopic guidance. It helps to mark the surface anatomy of kidney and judge the depth of kidney (if not available, position of kidney should be ascertained with preprocedure X-ray, IVP or US).
- The biopsy site is usually lower pole of kidney (to avoid injury to renal vessels).
- The skin and subcutaneous tissues are infiltrated with 1% lignocaine.
- An exploratory needle is inserted and pushed forward 5 mm at a time with the patient holding his breath while pushing the needle until it enters the kidney and it swings up and down in an arc with respiration.

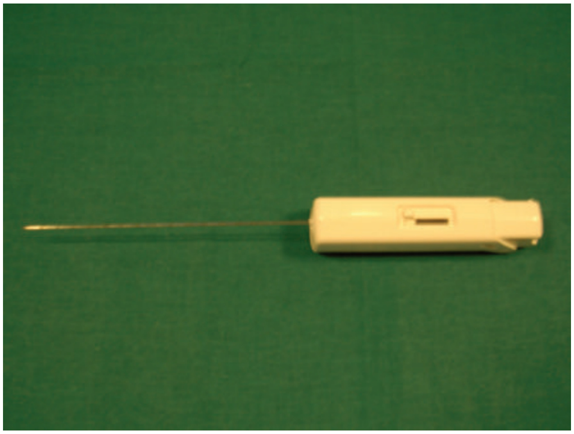

Figure 12.12 Tru-cut biopsy needle.

- The depth of kidney is measured and the distance is marked on the shaft of the biopsy needle.
- The exploring needle is withdrawn simultaneously injecting the tract with a local anesthetic.
- A small nick is made in the skin and the biopsy needle is introduced and pushed until it enters the kidney (ascertained by the swinging movements of the needle with respiration).
- The patient is asked to hold his breath in inspiration, the obturator is advanced quickly and then the canula of the needle is advanced to obtain a biopsy piece. The whole assembly is removed with the canula covering the obturator.
- The patient is allowed to breathe normally.
- The biopsy site is sealed with tincture benzoin.
- Patient is advised rest for 24 hours with monitoring of vital parameters.
- The specimen is sent for light microscopy, electron microscopy and immunofluorescence as separate pieces.
- Alternatively, Vim-Silverman needle can be used to perform kidney biopsy.
- Fine needle aspiration biopsy is a technique often used to monitor graft rejection.

5. **Complications**
    - Local bleeding with perirenal hematoma
    - Persistent hematuria with clot formation and urinary obstruction (microscopic hematuria is almost always present)
    - Injury to vessels and nerves
    - Formation of arteriovenous fistula with bleeding
    - Rarely an emergency nephrectomy is required for above complications
    - Death (rare)
6. **Limitations**

Renal involvement is patchy, and hence the biopsy histology may not reflect the whole pathology.

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Chapter 13

Diet

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CALCULATING NORMAL DIETARY REQUIREMENTS

The normal dietary requirement is calculated as follows:

1. Determine the desirable body weight. This can be assessed by referring to tables of LIC of India (Table 13.1) or can be calculated based on height.
   a. For men, the weight should be 106 lbs for the first 5 feet and 6 lbs for each inch above 5 feet
   b. For women, the weight should be 100 lbs for the first 5 feet and 5 lbs for each inch above 5 feet
2. Calculate calorie requirement as recommended by ICMR.

Table 13.1 LIC height–weight table

Height	Men		Women	
	kg	**lbs**	**kg**	**lbs**
1.523 m (5′ 0″)	—	—	50.8–54.4	112–120
1.5480 m (5′ 1″)	—	—	51.7–55.3	114–122
1.5738 m (5 ′2″)	56.3–60.3	124–133	53.1–56.7	117–125
1.5992 m (5′ 3″)	57.6–61.7	127–136	54.4–58.1	120–128
1.6246 m (5′ 4″)	58.9–63.5	130–140	56.3–59.9	124–132
1.6500 m (5′ 5″)	60.8–65.3	134–144	57.6–61.2	127–135
1.6754 m (5′ 6″)	62.2–66.7	137–147	58.9–63.5	130–140
1.7008 m (5′ 7″)	64.0–68.5	141–151	60.8–65.3	134–144
1.7262 m (5′ 8″)	65.8–70.8	145–156	62.2–66.7	137–147
1.7516 m (5′ 9″)	67.6–72.6	149–160	64.0–68.5	141–151
1.7770 m (5′ 10″)	49.4–74.4	153–164	65.8–70.3	145–155
1.8024 m (5′ 11″)	71.2–76.2	157–168	67.1–71.7	148–158
1.8278 m (6′ 0″)	73.0–78.5	161–173	68.5–73.9	151–163
1.8532 m (6′ 1″)	75.3–80.7	166–178	—	—
1.8786 m (6′ 2″)	77.6–83.5	171–184	—	—
1.9040 m (6′ 3″)	79.8–85.9	176–189	—	—

Maximum weight permitted: up to the age of 30 years, 10% above the standard weight; between 30 and 35 years, standard weight is the optimum weight; above 35 years, 10% below the standard weight.

  - **a.** Sedentary lifestyle – Desirable body weight in kg × 40 kcal/day
  - **b.** Moderately active lifestyle – Desirable body weight in kg × 50 kcal/day
  - **c.** Heavy duty worker – Desirable body weight in kg × 60 kcal/day
  - **d.** Add 300–500 extra calories for pregnant and lactating mothers
  - **e.** With advancing age, reduce calorie requirement by 5% for 40–50 year olds and 20% for 61–70 year olds

3. Desired distribution of calories
  - **a.** Carbohydrates: 70–80%
  - **b.** Fats: 10–15%
  - **c.** Proteins: 10–15%

4. Calorie distribution of meals
  - **a.** Breakfast: 20%
  - **b.** Lunch: 40%
  - **c.** Dinner: 40%

If snacks are consumed, calories are reduced proportionately from the main meals.

ASSESSMENT OF NUTRITIONAL STATUS

1. History
  - **a.** Details of daily diet
  - **b.** Recent change in body weight
  - **c.** Intake of drug(s) and alcohol
  - **d.** Symptoms of nutritional deficiency
  - **e.** Systems review

2. Physical examination
  - **a.** Anthropometry, body mass index

3. Signs of nutritional deficiency

Signs of nutritional deficiency include the following:

Physical finding	Deficiency
• **Wasting**	Energy
• **Skin**	
Pellagra	Niacin
Easy bruising	Vitamins C and K
Crazy pavement dermatosis	Protein
Scrotal and vulval dermatoses	Riboflavin
Rash	Zinc, essential fatty acids
• **Hair**	
Lack luster, thinning or loss	Protein
Premature whitening	Selenium
Flag sign	Protein
• **Eyes**	
Night blindness, xerosis (Bitot's spots), keratomalacia	Vitamin A
• **Lips**	
Cheilosis	Iron, riboflavin, pyridoxine, niacin
Glossitis	Iron, riboflavin, pyridoxine, niacin
Spongy, bleeding gums	Vitamin C
• **Nails**	
Spooning (koilonychia)	Iron
Flattening (Platonychia)	
• **Musculoskeletal**	
Muscle wasting	Protein
Frontal bossing, knock knees, chest deformities, bony tenderness, muscle weakness	Vitamin D
• **Gastrointestinal tract**	
Diarrhea	Niacin
Diarrhea + dysgeusia	Zinc
Plummer–Vinson syndrome	Iron
• **Central nervous system**	
Peripheral neuropathy	Thiamine, vitamin B12
Subacute combined degeneration	Vitamin B12
Cognitive and sensory deficits	Pyridoxine, vitamin B12
Beriberi (dry)	Thiamine
Dementia	Niacin
Dementia	Vitamin B1, B12, niacin
Tetany	Vitamin D
• **Cardiovascular system**	
Beriberi (wet)	Thiamine
• **Others**	
Puffy face, pitting edema	Protein
Loss of subcutaneous fat	Calorie
Goiter	Iodine
Diarrhea, dementia, dermatitis (pellagra)	Niacin

THERAPEUTIC DIETS

Obesity

Daily total calorie intake is reduced by 800–1000 calories. The aim is to reduce weight by 2.5–4 kg/month. Substituting part of carbohydrate calories with proteins helps in reducing the weight.

Foods to be avoided – Sugars, sweets, toffees, chocolates, corn flour, custard powder, jam, pastries, puddings, rich desserts, ice cream, sweet biscuits, nuts, condensed milk, salad dressing and mayonnaise, thick sauces and soups, fatty meats, beetroot, fried food, pork, sausage and meat with gravy.

Foods permitted – Brinjal, French beans, cabbage, cauliflower, cucumber, lettuce, mushrooms, onion, pumpkin, radish, spinach, tomato, turnip, green pepper and fresh fruit squashes.

Sample diet

Morning – 1 cup tea or coffee (no sugar) with 2 tablespoon milk

Breakfast – 1 boiled egg, 1 slice bread, 1 orange

Lunch – 1 bowel clear soup, 3 small size thin chapatis, 1 piece fish or 1 katori (2–3 pieces) meat curry, 1 medium katori green leafy vegetables, salad as desired, 1 apple

16.00 hours – 1 cup tea or coffee (no sugar) with 2 tablespoon milk, 2 toasts, 1 medium katori rice

Dinner – 1 medium katori fish curry or ½ medium katori thick dal, 1 medium katori vegetable, salad as desired

Bedtime – 1 cup skimmed milk (no sugar)

This diet provides 1200 calories, carbohydrates 170 g, proteins 60 g, fat 35 g. For pure vegetarians, approximate food exchanges are to be substituted (refer food exchanges).

Underweight

Addition of approximately 500 calories/day results in weight gain of 0.5 kg/week.

High protein diet of 2–3 g/kg may be advised for desired body weight. Vitamin supplements are advised. Underlying cause should be treated.

Sample diet

Morning – 1 cup tea or coffee with sugar, 2–3 biscuits

Breakfast – 1 or 2 eggs, 1 bowl sooji porridge with milk and sugar, 2 slices bread or toast with butter (30 g) and jam, jelly or honey, 1 cup milk with sugar, 1 banana

Midmorning – 1 glass chickoo milk shake or fruit juice, 1 snack

Lunch – 1 bowl soup, 125 g meat, fish or poultry, 2 medium size chapatis with ghee, 1 medium katori rice pulao, 1 medium katori cooked vegetables with potato, 1 medium katori curd, 1 bowl fruit with custard

16.00 hours – 1 cup tea with milk and sugar, 2 cheese sandwiches, 1 slice cake

Dinner – Same as lunch

Bedtime – 1 glass milk, 2 biscuits

This diet provides 3000 calories, proteins 100 g, and is adequate in all other nutrients. For vegetarians, appropriate food exchanges should be used.

Between-meal snacks – Fruit or fruit drinks, ice cream, milk or milk drinks (flavored milk, malted milk, milk shake, hot milk), biscuits, sandwiches (filled with egg, cheese, meat, banana, dates, honey, jam), toast, nuts, desserts containing milk and eggs may be taken.

Congestive cardiac failure (CCF)

Calorie intake as calculated

Carbohydrates should form main dietary constituent

Proteins – 1 g/kg body weight

Avoid fried foods

Avoid sodium till congestive cardiac failure (CCF) is controlled, then up to 3 g/day is allowed

Potassium replacement

Fluid restriction

- **High salt-containing foods to be avoided** – Cured meat, fish, canned meats, vegetables, soups, cheese, bottled sauces, pickles, sausages, cakes, biscuits (containing baking soda)
- **High potassium-containing foods (greater than 200 mg/100 g)**
- Vegetables – Spinach, amaranth, potato, suran, coriander leaves, dry lotus stem, sword beans
- Fruits – Chickoo, ripe mango, lemon, amla, sweet lime (mosambi), apricot (fresh), plums, peaches, grapes, cherries, dry fruits, nuts
- Cereals – Wheat flour, bajra, ragi, maize, all pulses
- Others – Tea, coffee, chocolates, jaggery, dry chilies, coriander seeds (dhania), cumin seeds (jeera), fenugreek seeds (methi), meat products
- **Low potassium-containing foods (less than 100 mg/100 g)**
- Vegetables – Peas, cucumber, dudhi, padwal, papdi, lettuce, pink radish, beet root, field beans, knol khol, parwar, turia, tinda, methi leaves
- Fruits – Orange, banana, pineapple, guava, pear, papaya
- Milk – Buffalo milk
- Cereals – Rice, rawa
- Others – Sago, rajgira seeds, arrowroot flour, tamarind pulp

Sample diet for CCF

Morning – 1 cup tea or coffee with 1 teaspoon sugar and milk from allowance

Breakfast – 1 egg (unsalted), 1 toast with jelly or marmalade, 1 cup milk with sugar, 1 fruit

Lunch – 90 g unsalted meat, chicken or white fish that may be grilled or fried in oil, 1 serving rice, 1 serving vegetable (cooked), salad (unsalted)

16.00 h – Tea or coffee with milk from allowance, 2 slices bread

Dinner – 60 g unsalted meat, fish or pulse, 1 serving rice, 1 serving vegetables, salad if desired, 1 fruit or fruit juice

Bedtime – 1 cup milk

Allowance for the day – 250 ml milk, 30 g low-salt butter

This diet provides 1600–2000 calories, proteins 60–90 g and sodium 40 mEq. No salt is to be used in cooking or at the table. Avoid all cured meat and fish, all canned meats, fish, vegetables and soups, cheese, bottled sauces, pickles, sausages and all foods made with baking soda (e.g. cakes and biscuits).

Ischemic heart disease

- Proteins – Normal intake
- Fats – Dietary cholesterol needs to be reduced in the presence of hypercholesterolemia. The total allowance of dietary fat remains unchanged. It should be equally distributed between saturated, polyunsaturated and monounsaturated fatty acids (30, 40 and 30%, respectively).

Rich dietary sources of saturated fat, high in cholesterol

Animal fats – Beef, meat, pork, organ meat

Fats procured from dairy products, such as milk, cream, butter (polyunsaturated acids, 3.6%), ghee (polyunsaturated fatty acids, nil), egg yolk.

Hydrogenated vegetable oils, e.g. margarine and vegetable ghee (polyunsaturated fatty acids, 1.9%)

Natural vegetable products, such as coconut and palm oils

Diets containing unsaturated fats (low cholesterol diet) are not restricted. Vegetable oils high in polysaturated fatty acids are safflower, sunflower, groundnut and cottonseed oils

Hypertension

- Calories – Adequate calories should be taken unless patient is obese.
- Proteins – Normal proteins (50–60 g) are required for a person with optimum weight and mild hypertension. However, in case of severe hypertension with renal insufficiency, proteins should be restricted to 20 g, as it is difficult to achieve salt restriction without protein restriction.
- Fats – High intake of animal fats and hydrogenated oils is discouraged. Approximately 40–50 g of fats are permitted.
- Carbohydrates – Carbohydrates should constitute the major bulk of calories.
- Vitamins – In normal amounts.
- Minerals – Sodium is restricted to 4–6 g/day. Sour lime or vinegar may be used to make food more palatable.
- With potent diuretics, strict salt restriction may not be mandatory. Additional potassium supplements with fruit juices or coconut water may be required to prevent diuretic-induced hypokalemia.
- Miscellaneous – Fluid restriction is required with severe hypertension.

Sample diet for hypertension

Morning – 1 cup tea with 1 teaspoon sugar and 2 tablespoon milk

Breakfast – 4 slices bread, 1 cup milk, no sugar, 1 glass buttermilk

Lunch – 2 medium size chapatis, or 1 medium katori rice, 1 medium katori dal, 1 medium katori vegetables

16.00 h – 1 cup tea with 1 teaspoon sugar, 2 toasts

Dinner – 2 medium size chapatis, 1 medium katori vegetables, 1 medium katori dal

Bedtime – 1 cup skimmed milk, no sugar

Allowance of fats and oils per day: 20 g. This diet provides 1320 calories, carbohydrates 198 g, proteins 51 g, fats 40 g.

Dietary advice while on oral anticoagulation

- Diet low in vitamin K
- Avoid vegetables, such as cauliflower, broccoli, cabbage with high vitamin K content
- Restrict leafy vegetables, such as spinach, turnip-greens, lettuce and brussels sprouts
- Avoid organ meats, such as liver
- Avoid bacon and ham
- Restrict strawberries and peaches
- Quit smoking (vitamin K content of cigarettes is high)

Acute renal failure

- Sodium balance needs to be maintained to avoid hyponatremia (due to excessive fluid intake) and hypernatremia (due to excessive sodium bicarbonate administration).
- Hyperkalemia should be avoided. (It is secondary to hypercatabolic state and acidosis.)
- Diet is dependent upon the severity of acute renal failure (Table 13.2 gives the examples of

Table 13.2 **High carbohydrates, high fat and protein-free diets for acute renal failure**

	Amount	CHO (g)	Protein (g)	Fat (g)	Sodium (g)	Calories (mg)
Borst diet*						
Sugar	150	150	—	—	—	600
Unsalted butter	100	—	—	81.0	0.980	729
Corn starch	150	130.5	0.75	0.3	0.006	525
Water	QS to 1500 ml					
Total	1500 ml	280.5	0.75	81.3	0.986	1854
Bull diet*						
Dextrose	400	400	—	—	—	1600
Peanut oil	100	—	—	100	—	900
Acacia	QS to emulsify	—	—	—	—	—
Water	QS to 1000	ML				
Total	1000 ml	400	—	100	—	2500

*Of historical interest only
QS - Quantity sufficient

diets advocated in the past). While restricting the fluid intake, adequate calorie intake should be ensured. If required, patient may be tube fed. In patients with inability to tolerate enteral feeds, parenteral nutrition with hypertonic nutrient solution is indicated. The total calorie requirement of these patients is high.

Nephrotic syndrome

Patients with nephrotic syndrome are often malnourished and wasted. Their appetite is reduced, and there is hypercatabolism. Therefore, the calorie requirement is high. The optimal protein intake in patients with nephrotic syndrome has been a debated matter. Daily 0.8 g/kg protein of high biological value and 1 g of protein per gram of protein loss has been advocated.

In patients with edema, salt intake should be restricted to 50–70 mEq/day (3–5 g/day of common salt). Salt restriction has the added advantage of potentiating the antiproteinuric effect of angiotensin-converting enzyme inhibitors.

Sample diet for nephrotic syndrome

Morning – 1 cup tea with 2 teaspoon sugar and 1/3 cup milk

Breakfast – 2 eggs (boiled), 2 slices bread or 2 idlis with 2 teaspoon butter, 1 glass milk with 2 teaspoon sugar

Midmorning – 1 handful of mixed roasted groundnuts and chana

Lunch – 2 medium size chapatis, 1 medium katori rice, 1 medium katori dal or 2 fish pieces, 1 medium katori vegetables, 1 medium katori curd

16.00 h – 1 glass milk with 2 teaspoon sugar with 1 tablespoon proteinules

Dinner – 2 medium size chapatis or 4 puris, 1 medium katori rice, 1 medium katori vegetables, 1 medium katori dal, 1 medium katori kheer or shrikhand

Bedtime – 1 glass milk with 2 teaspoon sugar

This diet provides 2700 calories, carbohydrates 330 g, fat 90 g, proteins 100 g, sodium 22 mEq and potassium 65 mEq. Substances rich in sodium are avoided during the stage of fluid retention.

Chronic kidney disease

Kidney disease outcome and quality initiative guidelines

It is important to provide adequate calories to enhance positive protein metabolism. Protein malnutrition is an important cause of morbidity and mortality in patients with chronic kidney disease (CKD).

- For predialysis, patients with CKD 30–35 kcal/kg/day should be provided with a protein intake of 0.6 g/kg/day.
- For patients on maintenance dialysis, optimum protein intake should be at least 1.3 g/kg/day. Calorie intake should be 35 kcal/kg/day for patients up to 60 years of age and 30 kcal/kg/day for patients above the age of 60 years.

Renal calculi

- Adequate fluid intake to ensure urine output of 2 l or more per day
- Restrict foods rich in calcium and oxalates
- **Calcium-rich foods** – Beans, cauliflower, milk and milk products (not butter and ghee), potatoes, molasses, egg yolk, figs
- **Oxalate-rich foods** – Chickoo, spinach, tea, tomato, cashew nut, custard apple, chocolates, beef, strawberries

Gout

- High carbohydrate diet may be advised during an attack of gout
- Avoid/treat obesity
- Preferably consume proteins of vegetable origin
- Adequate fluid intake to ensure 2 l or more urine output per day with twice nocturnal urination
- Avoid high-purine foods

Purine content of foods

Low-purine foods	Medium-purine foods	High-purine foods
Vegetables, fruits, milk, eggs, cheese, bread, cereals, butter, nuts, sugar, sweets, fats	Meat, chicken, French beans, green peas, lentils, spinach, brinjal, cauliflower, pulses, chickoo, custard apple, oat meal	Sweet breads, sardines, liver, kidney, meat extracts, gravies, brain, fish roe

- Low-purine foods can be consumed without restriction
- Medium-purine foods allowed intermittently (any one or two once/week)
- High-protein foods to be totally avoided
- Alcoholic drinks rich in purines (beer, rum, whisky) to be totally avoided. Wines are allowed
- Avoid fructose-containing soft drinks
- Low-fat dairy products have a protective effect (lower serum uric acid)
- Vitamin C (has significant uricosuric effect)

Peptic ulcer

Most authorities now believe that strict dietary restriction has no role in the management of peptic ulcer. Importance is given to regular well-balanced diet. This helps in tissue healing. Three regular meals are advocated.

Patients should avoid

- Diet that causes discomfort
- Snacks, especially at bedtime
- Frequent ingestion of milk (it may have a counter productive effect)
- Excess tea, coffee, alcohol and cola drinks
- Cigarette smoking

Irritable bowel syndrome

- High-fiber diet (cooked bran, pectin)
- Avoid cabbage, turnips, radish, legumes (increase gas production)
- For patients with lactose and fructose intolerance, avoid lactose- and fructose-containing foods
- Low-fat diet
- Small frequent feeds
- Avoid or decrease swallowing of air (rapid eating, carbonated beverages, smoking, chewing gum, all increase swallowing of air)

Constipation

- Proteins – Normal 60–70 g/day
- Carbohydrates – Fruits, such as figs, dates, banana, chickoo, apple, apricot and raisins, are helpful. High-fiber foods, such as leafy vegetables, salads, china grass (agar agar) form bulk, stimulate peristalsis and facilitate bowel movement
- Fats (not for obese patients) – For thin patients, allow cooking oils and desi ghee liberally to lubricate bowel and stimulate bile flow for proper digestion
- Calories as per the weight and age
- Yeast (rich in vitamin B complex) regulates bowel function
- Adequate minerals, required for bowel action
- Plenty of fluids – Warm water, morning tea
- Morning exercise

Diarrhea and dysentery

- Proteins in the form of curds, buttermilk, skimmed milk
- Carbohydrates, such as kanji from rice or sago, vegetable puree
- Restrict or avoid fats
- Calories – Adequate or on lower side for a few days
- Dehydration initially should be corrected by intravenous fluids. Electoral powder; after 1–2 days, salted biscuits
- Avoid ghee, butter, sweets, vegetable salads, nuts, spicy fried foods, papads, pickles, chutney

Inflammatory bowel disease (ulcerative colitis and Crohn's disease)

- Proteins – 1–1.5 g/kg/day of high biologic value for malnourished patients. Consumption of milk should be encouraged
- High-calorie diet (40–50 kcal/kg/day) for malnourished patients
- Bulk producing vegetables and vegetables with seeds restricted
- Mineral and vitamin supplements – Iron, zinc, potassium, B-complex vitamins and vitamin E
- Avoid fatty fried foods
- Avoid pickles, papads, chutney, spices
- Adequate fluid intake
- Frequent small feeds

Infective hepatitis (without encephalopathy)

- Total calories as per nutritional status
- Proteins (up to 1.5–2.0 g/kg BW)
- High-carbohydrate diet (approximately 300–400 g/day)
- Moderate amount of fat in the diet to make food palatable. No need to totally avoid dietary fat
- Frequent feeds
- B complex and multivitamin supplements
- No alcohol

Cirrhosis of liver (without encephalopathy)

- Total calories as calculated
- Proteins (up to 1–2 g/kg BW)
- Carbohydrates, fats as for infective hepatitis
- Low-sodium diet (1 g/day) in the presence of ascites and edema
- No alcohol
- Mineral and vitamin supplements

Hepatic encephalopathy

- In patients with chronic or recurrent encephalopathy, total protein restriction is not necessary (0.8 g/kg BW or even higher amounts are permitted). Vegetable proteins preferred
- Branched-chain amino acids – Leucine, isoleucine, valine
- High-carbohydrate diet
- Adequate calories
- Vitamin and mineral supplements including vitamin K
- Restricted fluid and salt intake

Disorders of gallbladder (cholecystitis, cholelithiasis)

- Intake of fat should be restricted to 20–30 g during acute attack of cholecystitis and up to 50–60 g at other times. Fat induces pain and contributes to obesity.
- Calorie restriction is guided by patient's body weight. Major part of the calories should be provided by carbohydrates. Dietary cholesterol should be reduced.
- Foods rich in cholesterol and saturated fat are egg yolk, beef, pork, organ meats with fat, whole milk, cream, butter, cheese, lard, saturated cooking oils (vanaspati), ghee and coconut and olive oil. Foods low in cholesterol are vegetables, poultry products and fish.

Diabetes mellitus

Diet is an important facet of the treatment of diabetes. Diabetic diet restricts carbohydrate intake while meeting protein and energy requirements to maintain normal weight in adults and growth in children.

Diabetic diet should be tailor-made and must consider the patient's height, weight, daily activities, medications and personal likes and dislikes. Out of the total calories provided, 60% may be from carbohydrate, 20% from proteins and 20% from fats.

Carbohydrates – The daily intake of carbohydrates should range from 100 g (the minimum to prevent ketonuria) to a maximum of 240–260 g. If the daily intake of carbohydrates is 240 g, approximately 50 g should be provided in each of the three meals, 20 g each in three snacks and 30 g in 300 ml of milk. Foods rich in sucrose and other sugars should be kept to a minimum.

Fats – Fat content of the diet is markedly restricted in an overweight patient with diabetes. Patients with diabetes have an increased risk of death from ischemic heart disease, and since this may be related to the amount of saturated fat in the diet, the total amount of fat should be adjusted to bring the total energy to the desired level.

Proteins – Patients with diabetes need as much proteins as a healthy individual, i.e. 1 g of protein per kg body weight. This is provided by 50–60 g of dietary protein. Children need higher amounts for growth.

Spacing of meals – Having two large meals is customary in India, but it is not advisable for a patient with diabetes.

Patients with insulin-dependent diabetes must eat multiple meals to avoid hypoglycemia. Their meals should be spaced according to the type of insulin they are taking and the period of peak action of insulin.

Between-meal snacks, including a small meal before bedtime, are often essential for patients with diabetics. They are particularly important to children, adolescents and certain adult patients who have a high daily calorie requirement.

Avoid list in diabetes mellitus

- Sugar, sweets, honey, jaggery
- Sweet drinks, carbonated drinks
- Cakes, pastries, cream, beer, wines
- Sweet pickles, sweetmeats
- Dried fruits, nuts
- Fruits – Bananas, mangoes, chickoos, grapes, sitafal
- An average size orange, sweet lime, apple or guava can be taken daily. Small-sized papaya, small piece of watermelon and few strawberries are allowed (any of these two fruits are allowed daily).

Diet for obese patients with diabetes (1000 calories)

Early morning – 1 cup of light tea without sugar and with little milk, 1 small cup of milk (toned) without sugar, 2 slices of bread without butter

Lunch – 2 small phulka or 1 medium size chapati or 1 medium bowl rice, ½ medium bowl dal (semisolid) or 1 bowl thin dal or 1 piece medium size fish or 1 piece medium size chicken with ½ bowl curry, 1 medium bowl leafy vegetables, 1 medium bowl vegetable salad, 1 glass of thin buttermilk, ½ teaspoon oil for cooking

Afternoon – 1 fruit (orange or apple or sweet lime), 1 cup of light tea without sugar, 1 slice of bread or 2 Marie biscuits

Dinner – 2 small phulka or 1 medium size chapati or, 1 medium bowl rice, ½ bowl dal or fish or chicken as above, 1 medium bowl of other vegetables, 1 medium bowl salads, ½ teaspoon oil for cooking.

Bedtime – 1 small cup of toned milk (4 oz without sugar)

EXCHANGE LISTS

With the need for a more flexible and realistic approach to food intake, the exchange system was introduced. In this system, foods commonly used in diet have been grouped according to the nutrient composition and designated as food exchange groups. Six food groups are listed, viz. cereal, pulses and meat, vegetables, milk, fat and fruits. Within any one group, food items can be freely exchanged since all the foods in that group in the portions indicated have approximately the same nutrient value.

Milk exchanges

Per exchange = 100 calories

½ cup (100 ml) buffalo milk
1 cup (200 ml) toned milk
Buttermilk from 200 ml of toned milk
1½ katori (medium size) curd

Cereal exchanges

30 g = 100 calories

1 medium size chapati (thin)
2 small size chapatis
2 bread slices
1 medium size bhakri
30 g rice flakes
1 medium katori cooked rice
2 small idlis
¾ medium katori macaroni or spaghetti
¾ medium katori sooji

1 big potato (125 g)
½ cup sweet potato or yam (75 g)

Pulses and meat exchanges

30 g pulse = 100 calories
1 medium katori dal
½ medium katori pulse curries
1 handful (30 g) roasted chana
5–6 pieces of medium size lean meat
5–6 pieces of medium size chicken
2 pieces of large size fish
1 cube (45 g) cheese

Vegetable exchanges

1. Group A

Per exchange = 25 calories
One exchange = 100 g raw vegetables
Brinjal
Cabbage
Cucumber
Cauliflower
Lettuce
Green leafy vegetables*
Tomatoes*

2. Group B

Per exchange = 35 calories
One exchange = ½ cup cooked vegetable (100 g)
Beet
Carrot*
Pumpkin*
Peas
Onion

See Table 13.3 for calorie values of common preparation food items.

*These vegetables have high vitamin A value. At least one serving should be included in the diet everyday.

Fat exchange

Per exchange = 45 calories
1 teaspoon oil
1 teaspoon butter
1 teaspoon vanaspati
1 tablespoon French dressing
6 small nuts (10 g)
2 tablespoon light cream (20%)
1 tablespoon mayonnaise

Fruit exchange

Per exchange = 40 calories
1 small apple (80 g)
4 halves dried apricots (20 g)
½ small banana (50 g)
10 large cherries (75 g)
2 dates (15 g)
1 dried fig (15 g)
2 large fresh figs (50 g)
12 grapes (75 g)
½ small mango (70 g)
1/8, 7″ diameter melon* (150 g)
1 small orange* (100 g)
½ cup orange juice* (100 g)
1/3 medium size papaya* (100 g)
1 small pear* (100 g)
½ cup cooked pineapple (80 g)
1 big guava* (120 g)
1 cup sliced watermelon (175 g)

*These fruits are rich sources of ascorbic acid (vitamin C). At least one exchange should be included in the diet everyday.

Table 13.3 **Calorie values of common preparation per serving****

Name	Household measures	Weight (g)	Calories
Cereal preparations			
Bajra bhakri	1 piece	45	110
Jawar bhakri	1 piece	80	200

Table 13.3 **Calorie values of common preparation per serving** (*continued*)**

Name	Household measures	Weight (g)	Calories
Bread	2 slices	40	80
Chapati	1	40	140
Chapati (phulka)	2	4	100
Khakra	1	50	130
Khichdi	1 katori	120	140
Paratha	1	80	250
Pulao (vegetable)	1 katori	120	200
Wheat (puri)	2	30	100
Rice – 30 g (raw)	1 katori	120	100
Corn flakes	4 tbsp	30	100
Biscuits			
Cheeselets	12	—	80
Crackerjack	1	—	25
Cream crackers	1	—	50
Glucose	2	—	67
Marie	4	—	50
Monaco	2	—	50
Orange cream	1	—	50
Nice	2	—	50
Cakes and pastries			
Plain cake	1 piece	75	280
Plain cake with chocolate icing	1 piece	87	302
Sponge cake	1 piece	50	150
Cake crème	1 piece	50	175
Pastry	1 piece	50	300
Swiss rolls	1 piece	50	180
Desserts and sweets			
Badam halwa	1 piece	100	570
Basundi (50% conc.)	1 katori	150 ml	390
Bread pudding	1 cup	150	170
Carrot halwa	1 serving	85	333
Custard	½ cup	130	164
Coconut rice	1 serving	150	640
Coconut burfi	1 piece	30	120
Dudhi halwa	1 serving	150	300

(*continued*)

Table 13.3 Calorie values of common preparation per serving** (*continued*)

Name	Household measures	Weight (g)	Calories
Faluda	1 serving	—	316
Fruit salad	1 serving	150	150
Fruit salad with cream	1 serving	150	300
Ice cream	1 slice	150	380
Kulfi	1 piece	50	200
Mahim halwa	3–4 pieces	100	570
Payasam	1 katori	150	360
Pie	1 serving	160	377
Pudding, bread with raisins	½ cup	110	210
Rabadi	1 katori	150	525
Rice kheer	1 katori	150	345
Shrikhand	1 katori	150	340
Gulab jamun	1 piece	25	200
Jalebi	1 piece	25	140
Besan ladoo	1 piece	30	140
Mohanthal	1 piece	4	250
Pedha	2 pieces	25	100
Puran poli	1 piece	75	260
Rasgulla	1 piece	50	150
Pulses and dal preparations			
Cooked dal	1 katori	150	100
Moong dal	1 katori	150	100
Sambhar	1 katori	150	110
Usal (chana)	1 katori	80	120
Watana roasted	1 handful	25	85
Amati	1 katori	150	100
Egg, fish and meat preparations			
Bacon	1 slice	8	50
Chicken with curry	1 serving	1 large piece	100
Egg boiled	1	30	60
Egg omelet	1	60	200
Fish fry	1 slice	60	100
Fish with gravy	1 slice	160	231
Meat curry	1 serving	3–4 pieces	100
Mutton chops	1 piece	50	170
Sausages	1	20	95

Table 13.3 **Calorie values of common preparation per serving** (*continued*)**

Name	Household measures	Weight (g)	Calories
Beverages			
Tea*	1 medium cup	150 ml	20
Coffee*	1 medium cup	150 ml	20
Milk with Bournvita	1 medium cup	150 ml	85
Buttermilk (salty)	1 medium cup	150 ml	45
Juices			
Apple juice*	1 glass	200 ml	100
Grape juice*	1 glass	200 ml	80
Lime juice*	1 glass	200 ml	60
Mango juice*	1 glass	200 ml	150
Orange juice*	1 glass	200 ml	64
Sugarcane juice*	1 glass	200 ml	76
Watermelon juice*	1 glass	200 ml	35
Aerated soft drinks			
Cola drinks	1 bottle	200 ml	80
Campa orange	1 bottle	200 ml	96
Energy	1 bottle	200 ml	167
Gold Spot	1 bottle	200 ml	90
Lemonade	1 bottle	200 ml	70
Mangola	1 bottle	200 ml	90
Soda	1 bottle	200 ml	5
Snacks			
Pohe	1 serving	95	275
Potato pattice	1 piece	55	180
Potato wada	2 pieces	100	300
Potato bhajia	1 piece	15	60
Masala dosa	1 plate	101	337
Rava dosa	1 plate	138	240
Samosa	1 piece	80	125
Chakli	2 pieces	40	140
Onion bhajia	6 pieces	45	150
Dahi wada	2 pieces	85	160
Idli	2 pieces	30	100
Dhokla	4 pieces	55	110

(*continued*)

Table 13.3 **Calorie values of common preparation per serving** (*continued*)

Name	Household measures	Weight (g)	Calories
Medu vada	2 pieces	75	300
Mung dal (fried)	1 packet	20	100
Potato wafers	1 serving	50	430

*Values are without sugar; 1 teaspoon sugar adds 20 calories

****Source:** Medical Therapeutics. G. S. Sainani, V. R. Joshi, P. J. Mehta (Eds), 2nd edition, Elsevier. Reprint [2005] with permission of publisher. We have picked up some parts of the text from above source with the kind permission of publisher Elsevier.

Chapter 14

Table viva voce

This chapter on table viva voce covers 200 selected questions that would be useful not only during table viva voce but also during discussion of long and short cases. In addition, we have also given few relevant viva voce questions along with the clinical cases in different chapters.

Q1. Tell me about high-fiber diet and its advantages.

There are two types of high-fiber diets

- Water soluble – Beans, guar gum, oat bran and pectin. These swell up and give a sense of fullness in stomach and thus induce early satiety. There is no desire to eat more. Glycemic index is low (glucose tolerance curve is flat.)
- Water insoluble – Wheat bran (hemicellulose of wheat) increases the volume of stools, which is evacuated with ease.

Advantages

- Prevent constipation and colon cancer
- Useful in the management of diverticular disease and functional bowel disorders
- Lower cholesterol.

Q2. Describe briefly the features of magnesium deficiency and hypermagnesemia.

The major part of magnesium (Mg) (65%) is present in the bones. The remaining (35%) is present in the cells. Plasma concentration usually follows that of calcium and potassium.

Causes of Mg deficiency are severe diarrhea, ketoacidosis. It is often associated with hypocalcemia, hypokalemia and hypophosphatemia.

Patients present with paresthesia, tetany, arrhythmias and fits. Treatment with magnesium salt, orally or intravenously (8 mmol $MgSO_4$ intravenous) given over 3 minutes to 2 hours depending upon severity.

Hypermagnesemia is usually iatrogenic due to

(i) excessive consumption of antacids containing magnesium and (ii) renal failure. It manifests with decrease in blood pressure (BP), neuromuscular depression, central nervous system (CNS) depression and coma.

Q3. Describe ocular manifestations of systemic diseases.

- Sarcoma of lids or conjunctive – Kaposi's sarcoma
- Conjunctivitis – Reiter's syndrome
- Conjunctival and corneal calcification – Hypercalcemia
- Keratoconjunctivitis sicca (dry eye, reduced tears confirmed by Schirmer filter paper test) – Seen in Sjögren's syndrome
- Episcleritis – Systemic lupus erythematosus (SLE), polyarteritis nodosa
- Scleritis – Rheumatoid arthritis (RA), Wegener's granulomatosis

- Anterior uveitis – Reiter's syndrome
- Iritis-Syphilis
- Lens opacities – Hypoparathyroidism
- Posterior uveitis, choroiditis – Granulomatous disorders e.g. tuberculosis, leprosy, sarcoidosis, syphilis, toxoplasmosis, brucellosis and Behcet's disease
- Endophthalmitis – Septicemia
- Exophthalmos – Hyperthyroidism
- Cytomegalovirus (CMV) retinitis – AIDS
- Amaurosis fugax – Retinal emboli
- Roth's spots – Infective endocarditis (IE)
- Retinopathy – Hypertensive, diabetic
- Retinal hemorrhages – Hypertension (HT), diabetes mellitus (DM) and leukemias

Q4. What are the important causes of pyrexia of unknown origin?

Infections

- Malaria
- Tuberculosis, paravertebral abscess
- Infective endocarditis
- Liver abscess (amebic, pyogenic)
- Pelvic abscess
- Kala-azar

Connective tissue diseases

- Systemic lupus erythematosus
- Polyarteritis nodosa
- Rheumatoid disease
- Still's disease
- Vasculitis

Malignant disorders

- Hodgkin's disease
- Non-Hodgkin's lymphoma
- Leukemias
- Renal cell carcinoma
- Hepatoma

Miscellaneous

- Drug fever
- Thrombophlebitis
- Pulmonary embolism
- Self-induced (factitious) fever

Q5. Describe the mechanisms of anemia in malaria.

- Hemolysis of infected red blood cells
- Splenomegaly with hypersplenism
- Impaired erythropoiesis
- Folate deficiency (secondary to increased demand)

Q6. What are the causes of tetany?

- Tetany is due to excitability of peripheral nerves, which may be due to either low serum calcium or alkalosis (ionized calcium is decreased, although the total calcium concentration remains unchanged). In patients with malabsorption, magnesium depletion may be a contributing factor. If the serum albumin level is low, the serum calcium level is low but this does not cause tetany as ionized calcium level is normal.
- Common causes of tetany
  - ☐ Hypocalcemia – Vitamin D deficiency, malabsorption and hypoparathyroidism
  - ☐ Alkalosis – Hyperventilation, oral intake of alkalies in excess and vomiting resulting in loss of gastric acid.

Q7. Outline the principles of treatment of tetanus.

- Patient should preferably be treated in a separate quiet room with dim lights
- Intravenous diazepam to control spasms
- Neuromuscular blockade with mechanical ventilation for uncontrollable spasms
- Intravenous antitetanus serum (3000 IU) to neutralize absorbed toxin
- Debridement and dressing of the wound to prevent further toxin absorption
- Intravenous benzyl penicillin 600 mg, every 6 hours
- Adequate nutrition and hydration
- Treatment of complications

Q8. Who discovered auscultation?

Auscultation was discovered by the French physician Laennec at the beginning of the nineteenth century. Before the discovery of stethoscope, auscultation was done by placing one's ear over chest wall and listening to heart sounds. Laennec once had a young lady as his patient in whom he felt a bit embarrassing to do direct auscultation by keeping his ear below her breast. He got an idea from children playing with a hollow tube and hearing the scratchy sound. At his next visit to his patient, he used a roll of thick paper to listen to heart sounds. With one end kept over patient's chest, he could hear heart sounds at the other end. Then, he made a monaural stethoscope using a wooden cylinder with a small hole drilled from end to end. This way a decorous distance was kept between the head of the physician and the chest of the patient. With the passage of time, a binaural stethoscope (which we use at present) with diaphragm and bell as chest piece was introduced.

Q9. Who discovered percussion?

Percussion was discovered by Auenbrugger who was the son of a wine seller. When he was a young boy, he was trained by his father to percuss over barrels of wine, which used to be kept in a cellar with dim light. By hearing the different notes of percussion, he was able to ascertain whether the barrel was full, empty or half full. When he joined medical school, he used this knowledge by percussing over chest and abdomen, and found different notes (dull, resonant, tympanic). Even now, we sometimes use direct percussion over pleural effusion and pneumothorax. With the passage of time, percussion got refined and use of pleximeter and percussion finger came into practice.

Q10. Describe nosocomial infections.

- It is a hospital-acquired infection
- Incidence is approximately 5% of all hospitalized patients
- The four modes of acquiring nosocomial infection are as follows:
  - **i.** Cross infection, e.g. droplet infection – Tuberculosis
  - **ii.** Autoinfection from the organisms harbored by the patient, especially from gastrointestinal tract (GIT)
  - **iii.** Infection from hospital environment, e.g. contaminated feeding bottles, bedpans, catheters, surgical instruments, blood, blood products (AIDS, hepatitis B, hepatitis C) and intravenous fluids. Legionnaire's disease is linked to contaminated cooling towers or hot water taps in hospitals. Infections such as typhoid, hepatitis A and E and amebiasis can be transmitted by workers in hospital kitchen.
  - **iv.** Spread through vectors, e.g. flies (typhoid and bacillary dysentery) and mosquitoes (malaria).

Q11. Describe oral replacement solutions (ORSs).

- It is prepared by dissolving WHO ORS packet in 1 l of water. One oral replacement solution packet contains 3.5 g of NaCl, 2.5 g $NaHCO_3$, 1.5 g KCl and 20 g of glucose. It contains, Na^+ (90 mEq), K^+ (30 mEq), HCO_3 (30 mEq) and glucose (111 mmol/l).
- Alternative solutions (useful in developing countries) – 30–50 g of rice powder or cereal is substituted for glucose (contains small chain oligosaccharides that provide substrate for cotransport of sodium but do not increase osmolality). Rice-based ORS has more nutritional benefits and also reduces the net fluid output of diarrheal stools.
- Administration is as per WHO recommendation –
  - **a.** In cholera, ORS 50–500 ml/kg, depending upon severity, is given in the first 4 hours and then 100 ml/kg till the diarrhea stops. After rehydration, oral replacement fluid is replaced with lower Na^+ containing fluids to prevent hypernatremia.
  - **b.** For mild diarrhea, ORS 50 ml/kg is given in the first 4 hours.
  - **c.** For moderate dehydration, ORS 100 ml/kg is given in the first 4 hours.
    - **i.** For each diarrheal stool, add ORS 10 ml/kg up to 240 ml.
    - **ii.** Assess patient after 4 hours; if dehydration persists, repeat same volume.
    - **iii.** Oral replacement solution can be used in all patients with dehydration provided kidney function is normal.

Q12. Describe lepra reactions and their management.

Two types of reactions are seen.

Type I

- Usually mild with no constitutional symptoms
- Presents as acute or subacute inflammation of pre-existing skin lesions
- Shows varying degrees of redness and edema of the lesions, which may desquamate or ulcerate
- Paralysis can develop in tuberculoid type of leprosy (mononeuritis multiplex)

Type II

- Due to immune complex deposition
- Serious reactions may rarely be fatal due to intercurrent infections or amyloidosis
- Presents mainly as eruptions of erythema nodosum leprosum (ENL), which are acute, painful, dusky red occurring over face, arms, legs and trunk
- Usually associated with constitutional features such as fever, myalgia, arthralgia, arthritis, iridocyclitis, lymphadenopathy, orchitis, neuritis and glomerulonephritis
- Remissions and recurrences are possible
- Eventually, recovery with residual hyperpigmentation might be possible

Treatment

- Mild to moderate reactions of both types are managed with salicylates and nonsteroidal anti-inflammatory drugs (NSAIDs).
- Type I reactions with threatened nerve palsy are treated with corticosteroids (prednisolone 40–60 mg OD initially, followed by maintenance dose of 5–10 mg/OD for a few months).
- For type II reactions, thalidomide is the drug of choice. First one or two attacks are treated with NSAIDs and prednisolone 40–60 mg daily for 1 week along with antimicrobials. For recurrent ENL, thalidomide 100–300 mg OD is given. Thalidomide should be avoided during pregnancy.

  In severe reactions, such as iridocyclitis, neuritis and orchitis, corticosteroids are preferred.

Q13. Briefly describe leptospirosis and its management.

- Leptospirosis is common in sewage workers, slaughter house workers and miners.
- In humans, three types of leptospiras (*Leptospirae icterohemorrhagica*, *Leptospirae canicola* and *Leptospirae hardjo*) cause infection.
- Rats, dogs and pigs are the reservoirs of infection.
- Infection is transmitted to humans by direct contact with urine or blood of infected animals or from water, vegetables and soil contaminated with urine and excreta of these animals.
- Stagnant water (particularly during monsoon) can be a source of infection.
- After infection, leptospirae spread to all tissues, but after 5–7 days may get localized to eyes and kidneys.
- Leptospirae may be excreted in the urine for a few weeks.

Weil's disease (*L. icterohemorrhagica*)

Clinical features depend upon the phase of the infection. Clinical features are biphasic. Phase I – It is due to septicemia and lasts for 3–10 days. Manifestations are fever with chills, muscle pains, headache, conjunctivitis, pain in abdomen, hepatomegaly, jaundice, skin hemorrhages, renal failure, hematuria, myocarditis and hypotension.

Phase II (immune phase) – It occurs between 6 and 12 days of the illness when leptospirae disappear from blood and IgM and IgG antibodies appear. In this phase, patients present with fever, hepatomegaly, renal failure, myocarditis and aseptic meningitis. This phase may last for a month followed by recovery.

Weil's disease (syndrome) is a severe form of leptospirosis. Fever is continuous with jaundice (due to intravascular hemolysis), azotemia, anemia and altered consciousness. Hemorrhagic manifestations such as petechiae, purpura, ecchymosis and epistaxis develop. Rarely, there may be subarachnoid, GI or adrenal hemorrhage. Renal and hepatic failure develop between 3 and 6 days of illness. Mortality is 5–10% in patients with jaundice.

Investigations

- Leucocytosis, low Hb, thrombocytopenia and raised erythrocyte sedimentation rate
- Deranged liver function tests (LFT) including prolonged prothrombin time
- Deranged renal functions, proteinuria, hematuria and granular casts
- Electrocardiogram (ECG) – Changes of myocarditis (low voltage, nonspecific ST–T changes)

Diagnosis is made by

- Rising IgM antibody titer, a sensitive test
- Dark-field microscopy to demonstrate leptospirae
- Culture

Management

- Crystalline penicillin (5–10 mega units daily) or doxycycline (100 mg BD) is effective.
- General supportive treatment and maintenance of fluid and electrolyte balance is necessary in severe cases.

L. canicola

It is transmitted by dogs and presents with febrile illness and aseptic meningitis.

L. hardjo

It spreads from cattle and presents with aseptic meningitis.

Q14. What are the different types of malaria?

Species	**Incubation period**	**Fever type**	**Relapses**	**Exoerythrocytic cycle**
Plasmodium vivax (common)	1–3 weeks	Tertian	Common up to 1 year	Yes
Plasmodium falciparum (common)	1–3 weeks	Quotidian or tertian	Recrudescence	No
Plasmodium malariae (less common)	2–4 weeks	Quartan	Recrudescence	No
Plasmodium ovale (less common)	1–3 weeks	Tertian	Common up to 1 year	Yes

Q15. What is tropical splenomegaly or Bengal splenomegaly syndrome?

- Seen in persons living in endemic malarial areas
- Due to repeated infections, possibly an immune response
- There is massive enlargement of spleen
- Malarial parasites are not present
- Serum IgM levels are elevated
- Antimalarial antibodies are present
- Treated with long-term malaria chemoprophylaxis, particularly with proguanil leads to regression of splenomegaly and confirms the diagnosis

Q16. What is nail-patella syndrome?

- It is a rare, familial mesenchymal tissue disorder with autosomal dominant inheritance. It involves joints, bones, finger nails and kidneys.
- Patella is hypoplastic or absent.
- There is subluxation of radial heads at both elbow joints.
- Finger nails are hypoplastic or absent (see Fig. 1.34).
- Classical renal lesion is rarefaction of the glomerular basement membrane with intramembranous deposits.
- Clinically, renal lesions manifest as proteinuria and over the years, renal failure develops in some cases. Treatment is that of renal failure.

Q17. Describe drugs that help to stop smoking.

Proven and effective drugs

- Bupropion slow release (SR)
- Nicotine (gum, lozenges, inhaler, patch, spray)
- Nortriptyline 25–75 mg at bedtime

Second-line drugs are useful in the presence of depression.

- Varenicline is a partial nicotine agonist. It reduces the craving for nicotine while blocking the effect of inhaled nicotine from cigarettes.
- Selegiline is a monoamine oxidase inhibitor; its efficacy is not significant.
- NicVax is a vaccine. It intercepts nicotine and prevents it acting on its receptors.
- Rimonabant (cannabinoid receptor antagonist) suppresses both appetite and desire to smoke. It has anorectic effect. The drug has been withdrawn in some countries due to adverse side effects.

Q18. Give important clinical examples of pharmacogenetics.

- Pharmacogenomics concerns variations in response to drugs due to individual genetic make up (variations), which leads to variable activity of drug metabolizing enzymes and other processes such as acetylation, hydrolysis and oxidation – examples
- Slow acetylators – Increased isoniazid (INH) toxicity
- Fast acetylators – Need higher drug dosage, e.g. INH
- Pseudocholinesterase deficiency – Prolonged paralysis due to succinylcholine
- Reduced hydroxylation
  - ❑ Excessive sensitivity to metoprolol and timolol
  - ❑ Increased phenytoin toxicity
  - ❑ Increased risk of conduction disturbances with tricyclic antidepressants
- Glucose-6-phosphate dehydrogenase (G6PD) deficiency – Increased risk of hemolysis with drugs such as primaquine, nitrofurantoin, sulfonamides and dapsone
- Reduced warfarin activity – Higher doses needed for therapeutic effect

Q19. What is the mechanism of jet lag?

- It results from rapid travel across multiple time zones and is most common with eastward travel.
- Circadian rhythm is modified by bright sunlight.
- Bright daylight delays normal sleep time while early morning light advances biologic clock with earlier sleep time.
- Melatonin 0.5–5 mg (oral) taken in the evening of arrival at the destination may help.

Q20. Briefly describe biological warfare.

- It is the use of microbial agents for hostile purposes.
- Potential biological agents are anthrax, botulinum toxin, brucellosis, salmonella, plague, tularemia, small pox, encephalitis and hemorrhagic fever viruses (Ebola and Marburg)

Q21. Name live vaccines.

- BCG
- Influenza
- Measles
- Mumps
- Rubella
- Varicella
- Oral polio
- Small pox
- Typhoid (live attenuated)
- Yellow fever

Q22. What is Kawasaki disease (mucocutaneous lymph node syndrome)?

- An acute vasculitic illness of childhood
- Onset – Acute with fever, cervical lymphadenopathy, erythema of skin and mucous membranes (lips, oral cavity, palms, soles) and desquamation of skin of palmar surfaces of hands and fingers.
- Pericarditis, myocarditis (even myocardial infarction [MI]) and cardiomegaly which is due to vasculitis of coronary arteries

Complications – Coronary artery aneurysm

Treatment – Intravenous gamma globulin (2 g/kg) as a single dose infusion over 10–12 hours along with oral aspirin 100 mg/kg daily for first few weeks and later 3–5 mg/kg/day for a long period.

(Intravenous IgG has to be given within 5 days of disease onset to be maximally effective.)

Q23. What is Mikulicz's syndrome?

- Mikulicz's syndrome is painless parotid and lacrimal gland enlargement.
- It occurs in TB, sarcoidosis, leukemia, lymphosarcoma, SLE and Sjögren's syndrome.
- Clinical features are similar to Sjögren's syndrome with dry mouth, dry eyes and salivary and lacrimal gland enlargement.

Q24. What is Munchausen syndrome?

- It is a chronic and severe form of fictitious symptoms.
- The patients feign illnesses of different systems, e.g. severe abdominal pain (hoping for exploratory laparotomy), bleeding that is not evident, pseudoanginal pain mimicking heart attack and atypical fits. Patients do this to gain medical attention.
- There is history of several hospital admissions. The cause is not clear.

Q25. What are the common types of fluids used IV in clinical practice?

1. Normal saline (0.9% saline) – It is isotonic with plasma and has the same sodium content as plasma (150 mmol/L)
2. 5% Dextrose is also isotonic. It contains 50 g/L of glucose (dextrose). Infusion of 5% dextrose is like giving water because the liver rapidly metabolizes all the glucose leaving only water. One liter 5% dextrose provides little energy (equivalent to 50 gm of glucose). More concentrated glucose solutions (25%, 50%) are available which are used for management of hypoglycemia. These being hypertonic are irritant to peripheral veins. Hence one has to be careful if one is using these hypertonic solutions more often.
3. Dextrose saline (one fifth normal saline) It is also isotonic. It contains 0.18% saline and 4% glucose. It has approximately the concentration of saline required for normal fluid maintenance.
4. Hypertonic and hypotonic saline solutions are available for use in special situations
5. Hartmann's solution which is considered more physiological; contains Na^+ 131 mmol/L, Cl 111 mmol/L, K^+ 5 mmol/L, lactate 29 mmol/L, HCo^3 29 mmol/L and Ca^{2+} 2 mmol/L

Q26. What are the diagnostic criteria of syndrome of inappropriate ADH secretion (SIADH)?

Describe the principles of its management.

Criteria for diagnosis

- Hyponatremia (serum Na^+ less than 125 mEq/l)
- Low plasma osmolality (less than 260 mOsm/kg)
- Concentrated urine (urinary Na greater than 20 mEq/l)
- Urinary osmolality greater than 500 mOsm/kg
- Absence of hypovolemia, edema and normal cardiac, hepatic, renal, adrenal and thyroid functions

Disorders associated with SIADH

Central nervous system disorders

- Stroke, subarachnoid and subdural hemorrhage, head injury
- Encephalitis, brain abscess, meningitis
- Guillain-Barré syndrome, acute intermittent porphyria

Pulmonary disorders

- Pneumonia, tuberculosis, lung abscess, positive pressure ventilation

Drugs

- Antineoplastics, lithium, cyclophosphamide, carbamazepine, antipsychotics

Malignancy

- Lymphoma of lung, CNS, duodenum

Miscellaneous

- Postsurgery

Treatment

- Mild, asymptomatic patient (serum Na greater than 120 mEq/l)

  (a) Treat the cause (b) Restrict fluid intake (c) Demeclocycline
- Symptomatic hyponatremia – Saline 3% and diuretic (furosemide)

Note – Serum Na^+ should be corrected slowly, 1 mEq/1 hour, to avoid central pontine myelinolysis

Q27. What is Milroy's disease?

Milroy's disease is an autosomal dominant disorder of congenital lymphedema. It may be associated with jaundice or diarrhea. Diarrhea is due to intestinal lymphangiectasia with protein-losing enteropathy.

The inherited malfunction of the lymphatics causes swelling of both legs, which is asymmetrical. It usually occurs in young girls. It is a benign condition, so patient has to be reassured. Patient is advised to use elastic stockings.

Q28. What is Tietz's syndrome?

It is costochondritis. Patient has pain and tenderness over costochondral junctions. Symptoms become worse with coughing, sneezing and movements of chest. Localized tenderness over costochondral joints (2nd–5th) confirms the diagnosis and differentiates it from other causes of chest pain, e.g. angina. Electrocardiogram is normal. It is treated with analgesics. In chronic cases, local steroid injection can be given.

Q29. What is *Helicobacter pylori* and how will you treat it?

- *H. pylori* is a gram negative, comma-shaped, rod-like organism.
- It has been implicated in gastroduodenal ulceration, inflammation and possibly cancer and lymphoma. It is considered a carcinogen.
- Transmission is by fecal-oral route. It survives in water.
- If gastric pH is alkaline, *H. pylori* can form colonies in stomach, which becomes a reservoir for reinfection.
- Diagnosis is made with endoscopic biopsy and demonstration of organism after special staining. Rapid urease test, serology and urea breath test are other tests for its diagnosis.

In India, *H. pylori* infection occurs early and by 20 years of age 75% adults have antibodies to *H. pylori*.

Treatment

Combination of proton pump inhibitor (PPi), 1–2 antibiotics and metronidazole is the treatment of choice

Rabiprazole +	20 mg bd × 2 weeks
Clarithromycin and/or	500 mg tds × 2 weeks
Amoxicillin +	500 mg tds × 2 weeks
Metronidazole	400 mg tds × 1 week

Q30. Describe briefly giardiasis.

- *Giardia intestinalis* (*Giardia lamblia*) is a global disease but more common in tropical countries. Cysts are passed in stools, which remain viable in water. Infection occurs due to drinking of contaminated water.
- After 1–3 weeks of ingestion, patient suffers from diarrhea, pain in abdomen, tenderness and gaseous distension. Patient feels tired and lethargic. There may be weight loss.
- Diagnosis is by stool examination. As flagellates get attached to the duodenal and jejunal mucosa, biopsy obtained while doing esophagogastroduodenoscopy (EGD) can also clinch the diagnosis.
- It is treated with tinidazole 1–2 g as a single dose or with metronidazole 2 g/daily for 3 days.

Q31. Describe Budd–Chiari syndrome (veno-occlusive disease).

- It results from hepatic vein obstruction due to thrombosis or a mass

Etiology

  - Contraceptive pill, pregnancy and malignancy are causes of this syndrome.
  - Toxins such as pyrrolizidine alkaloids (present in plants that are used to make Bush tea) can lead to veno-occlusive disease.
  - Thrombosis may occur due to blood diseases such as polycythemia, paroxysmal nocturnal hemoglobinuria (PNH), AT III, protein C and protein S deficiencies.
- Onset can be acute or insidious with the development of cirrhosis, portal HT, ascites and jaundice.

- Sometimes inferior vena cava may be involved causing peripheral edema.
- Abdominal Doppler ultrasound is often diagnostic. In doubtful cases, CT and MRI are helpful.
- Liver biopsy shows centrilobular congestion and fibrosis depending upon the duration of the disease.
- Hepatic venography is performed if TIPSS or surgery is planned.

Treatment

- Supportive treatment for ascites and liver cell failure
- Thrombolysis by streptokinase followed by heparin and warfarin
- Long-term anticoagulation
- For webs, balloon angioplasty with stenting
- Portacaval decompressive surgery
- Liver transplantation for acute fulminant or end-stage disease
- Prognosis is poor in patients with complete venous obstruction

Q32. Describe in brief the clinical features of carcinoid syndrome.

- Carcinoid syndrome is due to carcinoid tumor.
- These tumors are commonly seen in the appendix, ileum and the rectum, though they may occur at any site in the GIT.
- Intestinal carcinoids are of low-grade malignancy. They metastasize to the liver and the lymph nodes.
- When secretions of the neoplastic enterochromaffin cells of the tumor with liver metastases are released, patient gets systemic symptoms of carcinoid syndrome.
- Serotonin (5-HT) is released and its metabolite (5-HIAA) is excreted in the urine. In addition to serotonin, other hormones are also released.
- The cardinal features of the syndrome are flushing and diarrhea (precipitated by exercise, alcohol or certain foods);

Symptoms and signs due to local bowel tumors and liver metastases (hepatomegaly) may be present.

Right-sided heart valve lesions may be present.

Diagnosis is confirmed by 24-hour urinary 5-HIAA estimation.

Q33. What is Gardner's syndrome?

- Gardner's syndrome is characterized by multiple premalignant polyps in colon, dermoid tumors, fibromas and neurofibromas along with abnormal ocular fundus showing black spots due to congenital hypertrophy of retinal pigment epithelium.
- It is transmitted as an autosomal dominant disorder.
- It presents at young age with bloody diarrhea.
- Treatment is endoscopic polypectomy and in some patients subtotal colectomy.

Q34. Describe Osler–Weber–Rendu syndrome. (Hereditary hemorrhagic telangiectasia)

It is an autosomal dominant disorder. It presents with epistaxis or GI bleed due to lesions of mucous membranes. Telangiectasia in liver may result in cirrhosis. Arteriovenous (AV) malformations result in high output failure.

Q35. Describe Zollinger–Ellison syndrome.

The syndrome is due to gastrin-secreting pancreatic adenoma resulting in excessive acid output and peptic ulceration, (often multiple and in atypical locations). Occasionally, adenomas are located in the stomach or the duodenum. Majority of the adenomas (50–60%) are malignant; 30% are associated with multiple endocrine adenomatosis.

Patients suffering from recurrent peptic ulcers resistant to treatment and associated with diarrhea should be investigated for gastrin-secreting adenoma. Serum gastrin levels are elevated (greater than 1000 pg/ml). The adenoma can be localized with CT abdomen or octreotide scan.

Treatment

- Acid suppression – Proton pump inhibitors are the drugs of choice. Larger dose (e.g. omeprazole 40 mg BD) is required initially. The dose is reduced when symptoms resolve and

acid secretion is reduced. Long-term maintenance therapy is needed.
- Octreotide injection 100–500 μg subcutaneous, bid is given if PPi treatment fails.
- Surgery is indicated in patients without metastasis.
- Chemotherapy – Streptozocin, plus 5, fluorouracil are used to treat metastatic disease.

Q36. Describe in brief irritable bowel syndrome.

It is a functional disorder of GIT characterized by the following:
- Pain is felt in the abdomen.
- Diarrhea or constipation occurs either separately or alternately.
- Disturbed motility of colon seems to be the basis of the symptoms.
- Exact etiology is not known, but in some patients, psychological disturbances such as anxiety, mild depression and hypochondriasis seem to be responsible.
- Pain is felt usually in the lower abdomen (in both iliac fossae and is relieved after stools). Exaggerated gastrocolic reflex, gaseous distension and dyspepsia are other features. Passing of ribbon-like stools at times is quite common. There is colonic tenderness, particularly over sigmoid colon.
- Colonoscopy and barium enema are necessary to rule out an organic cause.
- Patients are reassured that there is no organic disease and that the symptoms are related to an intestinal motility disorder and spasm.
- Patients with constipation are advised high-fiber diet. Patients with diarrhea are advised to cut down milk, fruits and salads.
- For constipation, bulk laxative and for diarrhea codeine phosphate (30 mg tds) and/or loperamide (6–8 mg daily) are helpful.
- Anxious patients are advised exercise, yoga and change of lifestyle. In addition, one may try lorazepam (0.25 mg) or tryptanol (10–20 mg) at bedtime.

Q37. What is Peutz–Jeghers syndrome?

The syndrome is characterized by mucocutaneous pigmentation over lips, oral mucosa, soles and palms. In some cases, there may be GIT polyps (hamartomas) causing bleeding or obstruction. Malignant change occurs in very few cases.

Treatment is conservative or local excision.

Q38. What are the lipoprotein patterns?

*Phenotype	Lipoprotein (elevated)	Lipids (elevated)
I	Chylomicrons	Triglycerides
IIa	LDL	Cholesterol
IIb	LDL + VLDL	Cholesterol + triglycerides
III	VLDL + chylomicron remnants	Triglycerides, cholesterol
IV	VLDL	Triglycerides
V	Chylomicron + VLDL	Cholesterol + triglycerides

*Fredrickson phenotype

Q39. Describe briefly lipid-lowering drugs.

Class	Effect
1. Statins – Atorvastatin, ruzavastatin	↓ LDL, ↑ HDL, ↓ TGs
2. Nicotinic acid	↑ HDL, ↓ TGs (in lower doses) ↓ LDL (in higher doses) ↓ Lp (a)
3. Bile acid sequestrants	↓ LDL, ↑ HDL, ↑ TGs (±)
4. Fibrates	↓ TGs, ↑ HDL, ↑ LDL (±)
5. Ezetimide	↓ LDL, ↓ TGs, ↑ HDL

Q40. What are the manifestations of digitalis toxicity and how will you manage it?

Manifestations

Extracardiac – Nausea, vomiting or diarrhea, confusion, amblyopia. An ECG should be done in a patient on digitalis having these complaints.

Electrocardiogram abnormalities
- Sinus bradycardia
- Ventricular premature beats (pulsus bigeminus, trigeminus), atrial fibrillation

  - Paroxysmal atrial tachycardia (PAT) with block
  - Ventricular tachycardia, ventricular fibrillation, bidirectional ventricular tachycardia
  - Various grades of heart block – (Grade I most common)

Treatment

- Admit patients with severe toxicity to an ICU
- Stop digoxin
- Estimate serum electrolytes, serum creatinine, blood urea and digoxin levels
- Correct hypokalemia, hypomagnesemia and dehydration (oral or intravenous replacement depending upon severity)
- For severe sinus bradycardia, give injection atropine (0.6 mg)
- For complete heart block, temporary pacing. Isoproterenol is contraindicated
- For PAT, β-blocker
- For ventricular tachycardia, intravenous lignocaine or phenytoin sodium
- For ventricular fibrillation, DC defibrillation
- Fab (antidigoxin antibody fragments). Indications – Arrhythmias, serum potassium greater than 5 mEq/l, ingestion of large dose

Q41. Briefly describe Ebstein's anomaly.

- It is a congenital cardiac anomaly. There is downward displacement of tricuspid valve into the right ventricle with the result that a portion of right ventricle acts like right atrium. The atrialized right ventricle contracts poorly.
- Patient complains of breathlessness, palpitations, fatigue and cyanosis. S1 and S2 are widely split and S3 and S4 sounds are audible. These multiple heart sounds are classical of Ebstein's anomaly. Other important finding is pansystolic murmur of tricuspid insufficiency.
- Chest X-ray shows globular cardiomegaly.
- Electrocardiogram shows tall peaked P waves (like a Himalayan peak).
- 2D echo confirms the anomaly.
- Treatment is repair of tricuspid valve.

Q42. What is the importance of non-high-density lipoprotein-cholesterol (non-HDL-C) in atherosclerosis?

Non-HDL-C = Total cholesterol – HDL

Includes all lipoproteins that contain apolipoprotein B (Apo B) (low-density lipoprotein [LDL] + intermediate density lipoprotein (IDL) and very low-density lipoprotein (VLDL)

Non-HDL-C has strong correlation with total Apo B (the major atherogenic lipoprotein). Apo B levels are strong predictors of coronary artery disease (CAD). In the absence of Apo B estimation, non-HDL-C can be used in clinical practice.

It should be used as a screening test. One has to measure only total cholesterol and HDL-C (both can be estimated quite accurately, there is no need of fasting blood sample.) Fasting sample is essential for LDL measurement.

Q43. Presently what is the role of digoxin in the management of heart failure?

- Digoxin has a limited role these days due to the availability of effective alternatives, such as β-blockers, ACE inhibitors, diuretics and aldosterone antagonists.
- Digoxin is useful in patients with structural heart disease (myocardial involvement with systolic dysfunction) and in patients with atrial fibrillation to control the ventricular rate.
- It has been shown to decrease hospitalization duration of heart failure and give relief from symptoms, such as palpitations.

Q44. Describe briefly diabetic cardiomyopathy (CMP).

- Hyperglycemia causes microangiopathic changes in the small vessels of the heart, which leads to CMP.
- Diabetes is an important cause of heart failure. Men with diabetes suffer from heart failure twice more often than men without diabetes and women with diabetes have fivefold higher risk of heart failure than women without diabetes. Premenopausal women with

diabetes have lesser risk of cardiovascular disease than men and postmenopausal women.

- Patients with diabetes and with microalbuminuria should undergo 2D echo to detect CMP (left ventricular hypertrophy, systolic and diastolic dysfunction).
- For prevention of development of CMP, tight control of diabetes, HT and dyslipidemia is essential.

Q45. Describe briefly hyperhomocysteinemic CMP in DM.

- It is a recently recognized entity.
- It is seen in diabetic patients with hyperhomocysteinemia. Homocysteine level is elevated in patients with diabetes due to the impaired metabolism of glucose and reduced renal clearance. There is diastolic dysfunction.

In the normal myocardium, extracellular matrix functionally links endothelial cells to cardiomyocytes. In DM, extracellular matrix gets oxidized and accumulates between endothelium and cardiomyocytes. Hyperhomocysteinemia activates enzyme metalloproteinase that further delinks endothelial cells from cardiomyocytes and also increases the oxidative stress. This uncoupling of endothelial cells and cardiomyocytes leads to impaired diastolic relaxation and diastolic dysfunction. Vitamin B12 (500 mg), folic acid (2 mg) and pyridoxine (10–25 μg) are given daily to lower homocysteine levels.

Q46. What are the Do's and Don'ts in a patient with an implanted pacemaker?

- Avoid MRI unless the MRI machine is pacemaker compatible.
- Preferably avoid metal detectors during security check, as it may alter the programming of the pacemaker.
- Can use a mobile phone but preferably use the opposite ear (right heart pacemaker – left ear and left heart pacemaker – right ear). There is no contraindication to the use of electrical devices, such as electric shaver, electric tooth brush or microwave.

Q47. What is the role of stem cell therapy in treating cardiovascular diseases?

Experimental studies have shown that transfer of stem cells to infarcted part of the myocardium leads to improved tissue perfusion and contractile performance of the damaged heart.

Stem cell therapy has been tried in the past few years. So far, the clinical trials are encouraging. These studies underline the fact that stem cell therapy will play an important role in the management of cardiovascular diseases in future.

Stem cell therapy would be useful in nonischemic CMP also.

Q48. Describe the management of a pregnant woman with a valvular heart disease.

- Pregnancy is contraindicated in patients with severe valvular disease and heart failure, as heart failure is associated with premature labor, arrhythmias, maternal death and fetal loss.
- It is advisable to control CCF or surgically correct valvular defect in patients with Class III or IV heart failure, before planning pregnancy.
- Prophylaxis against IE is necessary as in a nonpregnant woman.
- Decompensation should be recognized and treated medically in time.
- Digoxin may be needed.
- ACE inhibitors are contraindicated.
- In such cases, emergency valve surgery can be carried out
- Bioprosthetic valves have better outcome than mechanical prosthetic valves as the later require anticoagulation therapy.
- Hospitalization is advised with heart failure
- Bed rest is advised from 20 weeks of gestation onwards.
- With class IV heart failure, abortion is an option.
- Amiodarone should be avoided to treat arrhythmias.
- In the presence of atrial fibrillation, anticoagulation is indicated (warfarin is to be avoided during first trimester).
- Rheumatic fever prophylaxis is to be continued.

- Peripartum antibiotics for prophylaxis against IE is advocated (controversial not agreed to by all).

Q49. Outline the management of anticoagulant therapy in a pregnant woman.

Indications

- Prosthetic valve
- Deep venous thrombosis (DVT) with pulmonary embolism
- Mitral stenosis with atrial fibrillation
- Symptomatic antiphospholipid syndrome

Drawbacks of anticoagulation therapy with warfarin - Bleeding during delivery and warfarin embryopathy risk in the first trimester

Considering these limitations of warfarin, the plan to be followed is as follows:

At an early stage after conception, replace warfarin with low-molecular weight heparin (LMWH) and continue it through the first trimester and then shift to warfarin in the second trimester, replace it with LMWH in the third trimester till delivery (still safer would be to stop warfarin before attempted conception and continue the regime as mentioned above).

Q50. What is hibernating myocardium?

During acute coronary syndrome, in some cases, there are hypocontractile areas of viable myocardium, which on revascularization may recover. This reversible dysfunctional myocardium is referred to as hibernating myocardium. It is important to identify hibernating myocardium to evaluate the benefit of revascularization procedures.

Positron emission tomography (PET scan) which measures myocardial blood flow shows that in hibernating muscle, blood flow is generally within normal range while the coronary flow reserve is severely reduced. Repetitive ischemia and stunning are the mechanisms that start the process of myocardial hibernation.

Q51. Describe the relationship between carotid artery intima-media thickness (CIMT) and CAD.

Carotid artery intima-media thickness determined by employing high-resolution B mode ultrasonography gives assessment of atherosclerosis that corresponds with the severity of coronary atherosclerosis. Trials with statins have shown that reduction in the severity of atherosclerosis as seen in carotid artery correlates with coronary angiographic studies.

Carotid artery intima-media thickness testing is a noninvasive procedure and gives information on the condition of arterial wall. It can be serially done to assess the effect of control of the risk factors on atherosclerosis.

Q52. What is the importance of systolic blood pressure (SBP) and diastolic blood pressure (DBP)?

Diastolic blood pressure is more important as a risk factor in young adults (less than 50 years of age), whereas SBP assumes importance after the age of 50 years. Systolic blood pressure increases continuously with aging, whereas DBP rises up to the age of 40 years and then levels off for some years. In the elderly, the DBP may decrease. Systolic blood pressure less than 140 mm Hg is associated with lower total mortality, cardiovascular events, stroke and heart failure. One must target to keep SBP less than 140 mm Hg, whatever the age of the patient. It is sometimes more difficult to control SBP than DBP.

With the increasing life span, more and more cases of high SBP are encountered. The pulse pressure that widens with age due to rise in SBP and fall in DBP determines the cardiovascular and cerebrovascular risk.

Q53. Should NSAIDs and cyclo-oxygenase (COX-2) inhibitors be advised following acute myocardial infarction (AMI)?

Cyclo-oxygenase-2 inhibitors are contraindicated in AMI as there is an increased risk of mortality and an increased risk of second attack of AMI. Nonselective NSAIDs (Ibuprofen, diclofenac) act on both COX-1 and COX-2 pathways. They increase mortality if used in large doses but the risk is less than with COX-2 inhibitors. Even so if required (to relieve musculoskeletal pain), NSAIDs can be used in small doses for a short time.

Q54. Describe briefly nutritional value of selenium

It is important and essential element having antioxidant property. It is required for the anti-oxidant glutathione peroxidase which reduces harmful free radicals. It has also antithrombogenic property and is required for sperm motility proteins. Its deficiency may lead to atheroma formation, increase chances of neoplasia, may cause cardiomyopathy. Selenium is present in cereals, nuts and meat.

Q55. What advice will you give to a patient of AMI at discharge to prevent second attack?

Diet and lifestyle management

- Diet – Avoid fried fatty foods, (less than 7% of total calories to be obtained from saturated fats, cholesterol less than 200 mg/day), consume plenty of salads, green vegetables and fruits.
- Alcohol – A glass of red wine or two small pegs per day are permitted
- No smoking/no tobacco consumption
- Tight control of HT
- Tight control of DM
- Control of dyslipidemia (LDL-C less than 100 mg/dl, non-HDL-C less than 130 mg/dl, triglyceride [TG] less than 130 mg/dl). Initiate niacin/fibrate to lower TG and raise HDL
- Control of weight – Desirable body mass index (BMI) 18.5–25 kg/m^2 or even lower for Indians
- Regular exercise program consistent with lifestyle, age and cardiac status after 6 weeks of discharge

Pharmacological

- Antiplatelet agents – Aspirin 75 to 162 mg/day, ± clopidogrel 75 mg/day. Aspirin reduces postinfarct mortality and reinfarction by 15–30%
- Angiotensin-converting enzyme (ACE) inhibitors for all, ARB in those who cannot tolerate ACE inhibitors
- Beta blockers in all; these reduce post-MI mortality rate by 25%
- Warfarin for patients having aspirin allergy and as an alternative to clopidogrel
- Antioxidants, though no definite evidence of benefit available
- Statins to all. Reduction of serum cholesterol reduces post-MI risk of recurrent infarction, lowers mortality

Q56. What is the use of β-blockers in heart failure?

- Beta blockers are useful in heart failure.
- These can be used in all grades of heart failure.
- Patients with heart failure and reduced LV ejection fraction benefit. These should be introduced as soon as LV dysfunction is detected in view of their favorable effects on survival and disease progression.
- Improve symptoms and reduce the risk of death.
- Carvedilol, bisoprolol and sustained release metoprolol succinate have been shown to lower mortality and relieve symptoms.

Q57. What is Leriche's syndrome?

It is saddle-shaped thrombosis at the aortic bifurcation. It leads to absence of femoral pulses, intermittent claudication of leg muscles, cold, clammy, pale legs and impotence.

Q58. Describe Canadian classification of angina pectoris.

Class 1 – On strenuous or unaccustomed exertion or prolonged exertion
Class 2 – On walking rapidly, uphill, climbing stairs, walking after meals, cold and emotional stress
Class 3 – Walking short distance at usual pace on level ground
Class 4 – At rest or on minimal activity

Q59. What are the contraindications for exercise testing?

Absolute

- Uncontrolled, unstable angina within 48 hours of MI
- Symptomatic or severe aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism
- Acute myocarditis
- Acute pericarditis
- Symptomatic arrhythmias or hemodynamically unstable patient
- Acute aortic dissection

Relative

- Moderate to severe valvular stenosis
- Left main CAD

- Tachyarrhythmia, bradyarrhythmia
- Systolic blood pressure greater than 200 mmHg, DBP greater than 100
- Hypertrophic obstructive CMP (HOCM)
- Electrolyte imbalance
- Systemic illness
- Physical, mental impairment

Q60. Describe AMI mortality as per Killip classification.

Class	PaO_2 (at room air)	Clinical	In hospital morality
1	Normal	No evidence of LVF	3–5%
2	Slightly ↓	Mild to moderate LVF	6–10%
3	Abnormal	Severe LVF Pulmonary edema	20–30%
4	Very abnormal	Cardiogenic shock	>80%

Q61. What are the indications for permanent pacemaker implantation?

Arrhythmia	Clinical manifestation
I. Sinus node dysfunction	With symptomatic bradycardia
II. AV block	Grade II heart block with symptomatic bradycardia
	Grade III heart block with symptomatic bradycardia
III. Tachyarrhythmias	Symptomatic
IV. Post AMI	With Grade II or III heart block
V. Congenital heart disease	With Grade II or III heart block
IV. Hypersensitivity carotid sinus	With syncope

Q62. What is refractory heart failure, and what are its causes? What is its treatment?

Refractory heart failure is persistence of symptoms after treatment.

Causes

- Persistent underlying causes, such as valvular heart disease, ischemic heart disease (IHD), uncontrolled HT
- Suboptimal treatment
- Noncompliance
- Excess salt intake
- Associated anemia, thyroid disease, IE
- Arrhythmias
- Nonsteroidal anti-inflammatory drugs, thiazolidinediones, calcium channel blockers

Treatment

- Treat/correct perpetuating factor, optimize treatment
- Biventricular pacing

Q63. Which antiarrhythmic drugs can be given orally for a prolonged period?

Drug molecule	Oral maintenance dose (mg)	Common indication
• Amiodarone	100–400 QID	AF/VT prevention
• Digoxin	0.125–0.5 tds	AF rate control
• Verapamil	80–120 q 6–8 hours	AF rate control, VT
• Diltiazem	30–60 q 6 hours	AF rate control/SVT
• Disopyramide	100–300 q 6–8 hours	AF/SVT/VT prevention
• Flecainide	50–200 q 12 hours	AF/SVT/VT prevention
• Quinidine	300–600 q 6 hours	AF/SVT/VT prevention
• Procainamide	250–500 q 4–6 hours	AF/SVT/VT prevention
• Sotalol	80–160 q 12 hours	AF/VT prevention
• Metoprolol	25–100 q 6 hours	AF rate control/SVT/VT
• Nadolol	40–120 mg/day	AF rate control/SVT/VT
• Acebutolol	200–400 q 12 hours	AF rate control/SVT
• Mexiletine	150–300 q 8–12 hours	VT prevention

AF, atrial fibrillation; VT, ventricular tachycardia; SVT, supraventricular tachycardia.

Q64. Which are the commonly used antiarrhythmic drugs given intravenously?

Drug	Loading dose	Maintenance dose	Indications
• Amiodarone	14 mg/minute for 10 minutes	0.5–1 mg/minute	AF, SVT, VT/VF
• Verapamil	5–10 mg over 3–6 minutes	2.5–10 mg/hour	SVT, AF
• Diltiazem	0.25 mg/kg over 3–5 minutes	5–15 mg/hour	SVT, AF, AFL rate control
• Digoxin	0.25 mg q 2 hours until 1.0 mg	0.125–0.25 mg/day	AF/AFL rate control
• Quinidine	6–10 mg/kg at 0.3–0.5 mg/kg/per minute	N/A	Prevent or convert AF/VT
• Procainamide	15 mg/kg over 60 minute	1–4 mg/minute	Prevent/convert AF/VT
• Lidocaine	1–3 mg/kg at 20–50 mg/minute	1–4 mg/minute	VT
• Esmolol	500 µg/kg over 1 minute	50 µg/kg per minute	AF/AFL rate control
• Metoprolol	5 mg over 3–5 minute	1.25–5 mg q 6 hours 3 doses	SVT, AF rate control
• Adenosine	6–18 mg (rapid bolus)	N/A	Terminate reentrant SVT involving AV node

AF, atrial fibrillation; SVT, supraventricular tachycardia; AFL, atrial flutter; VT, ventricular tachycardia.

Q65. What are the contraindications for ACE inhibitors?

- Serum creatinine greater than 2.8 mg/dl
- Bilateral renal artery stenosis
- Solitary kidney with renal artery stenosis
- History of ACE inhibitor-induced angioedema
- Pregnancy

Q66. How will you carry out prophylaxis of IE?

Procedures requiring prophylaxis against IE

- Dental extractions, dental implant placement, periodontal procedures, cleaning of implant or teeth when bleeding is expected, root canal procedure, sublingual placement of orthodontic bands
- Gastrointestinal tract procedures/surgeries – Biliary, sclerotherapy, esophageal stricture dilatation, intestinal mucosa surgery
- Genito-urinary tract (GUT) procedures/surgeries – Cystoscopy, urethral dilatation, prostate surgery
- Respiratory tract procedures/surgeries – Tonsillectomy, bronchoscopy, respiratory mucosa surgery

Antibiotics recommended for oral, respiratory tract and esophageal procedures

- Amoxicillin 2 g 1 hour before procedure (oral); or ampicillin 2 g ½ hour before procedure (intramuscular or intravenous).
- Alternatives for patients with allergy to penicillin
- Clindamycin 600 mg oral, 1 hour before or intravenous ½ hour before procedure, or cephalexin or cefadroxil 2 g before procedure
- Azithromycin or clarithromycin 500 mg oral 1 hour before procedure, or cefazolin 1 g intramuscular or intravenous ½ hour before procedure

Antibiotics recommended for GIT and GUT procedures

- For high-risk patients (prosthetic valve, past history of endocarditis, complex cyanotic heart disease, surgical systemic – pulmonary shunts) – Ampicillin 2 g intramuscular or intravenous + gentamicin 1.5 mg/kg intravenous or intramuscular ½ hour before procedure, followed by ampicillin 1 g intramuscular or intravenous or amoxicillin 1 g intramuscular or intravenous 6 hours after the procedure
- Alternative – Vancomycin 1 g intravenous over 1–2 hours, + gentamicin 1.5 mg/kg intravenous or

intramuscular within ½ hour of the procedure

- For moderate-risk patients (valvular heart disease, mitral valve prolapse [MVP] with mitral regurgitation congenital heart disease and HOCM) – Amoxicillin 2 g oral, 1 hour before the procedure or ampicillin 2 g intramuscular or intravenous ½ hour before the procedure.

Q67. Describe in brief coeliac disease

Celiac disease is a malabsorption syndrome due to intolerance to gluten in the diet. Local immunological response to the gluten component is responsible for the damage to the mucosa. Antibodies to gluten are found in the peripheral blood, and there is splenic atrophy. About 25% of patients give a positive family history.

The normal mucosa of small intestine, which has leaf-like villi, is altered at duodeno-jejunal flexure and the abnormal mucosa may extend distally. The main changes in mucosa show partial villous atrophy and subtotal villous atrophy (flat mucosa). The disease presents in children below 2 years of age when they start eating cereals. Child's growth is retarded and becomes irritable. Abdomen gets distended and stools are pale and bulky. Occasionally, the disease may present in adult life with features of malabsorption, diarrhea and anemia usually due to iron and folate deficiencies. Other clinical features are clubbing, stomatitis, aphthous ulcers, pigmentation, edema (secondary to hypoalbuminemia) and peripheral neuropathy.

Diagnosis is confirmed by abnormal jejunal biopsy and elevated IgG and IgM antibodies to gliadine. After taking gluten-free diet, jejunal biopsy becomes normal. For management, gluten-free diet along with iron and folic acid supplements help in recovery. To achieve gluten-free diets, one must exclude wheat, barley, rye and even oats.

Q68. What are the risk factors for DVT and how will you treat DVT?

Risk factors

- Age above 60 years
- Pregnancy, postpartum
- Immobilization, limb trauma
- Oral contraceptives, estrogen therapy, estrogen receptor modulators
- Cigarette smoking
- Hypercoagulable states, nephrotic syndrome
- Congestive cardiac failure
- Malignancy, myeloproliferative disorders (hyperviscosity)
- Sickle cell anemia
- Indwelling venous catheters

Treatment

- Main aim of treatment is prevention of pulmonary embolism
- Secondary aims – Symptomatic relief and prevention of chronic venous insufficiency and postphlebitic syndrome
- Anticoagulation (heparin, followed by warfarin or acitrom) (unfractionated heparin needs hospitalization and monitoring). Low-molecular weight heparin does not need monitoring and can be given at home. Both heparin and LMWH are equally effective
- Pain control (analgesics, avoid aspirin and NSAIDs)
- Keep affected extremity elevated, avoiding venous compression
- Bed rest is not absolutely mandatory
- Inferior vena cava filter for patients with lower extremity DVT with contraindication to anticoagulants or with recurrent emboli despite adequate anticoagulation (efficacy, long-term safety not proven)
- Thrombolysis (streptokinase, urokinase, alteplase)
  - ❑ More effective than heparin in prevention of postphlebitic syndrome but has higher risk of bleeding
  - ❑ Indicated with large proximal thrombus (iliofemoral veins) and phlegmasia alba
- Surgery
  - ❑ Thrombectomy, fasciotomy or both (indicated for phlegmasia alba unresponsive to thrombolysis).

Prevention

- For low-risk patients with anticipated period of prolonged immobilization (e.g. long air-travel)
  - Walking or periodic dorsiflexion of feet – 10 times/hour is adequate
  - Drug treatment – Not necessary
- For high-risk patients
  - Keep legs elevated
  - Low-molecular weight heparin or unfractionated heparin or anticoagulants
  - Intermittent pneumatic compression (not useful for hip and knee surgery); contraindicated in obese individuals
  - Graded compression stockings (benefit questionable)
  - If anticoagulation is contraindicated, temporary inferior vena cava filter.
  - For prevention of venous insufficiency and postphlebitic syndrome, knee high compression stockings are useful

Q69. Describe classification and treatment of CCF.

Congestive cardiac failure can be acute or chronic

Classification

- Left ventricular failure (LVF)
- Right ventricular failure (RVF)
- Biventricular failure
- High-output failure
- Low-output failure

The terms forward failure (for LVF) and backward failure (RVF) indicate the primary seat of pathology. Ultimately, failure of one side affects function of the other side.

Principles of treatment of CCF

a. Decrease cardiac work load
- Physical and mental rest
- Vasodilators
- Beta blockers
- Weight reduction (in obese individuals)

b. Salt and fluid restriction
- Restriction of salt and fluid intake
- Diuretics
- Fluid removal – Tapping of ascites and dialysis

c. Increasing myocardial contractility
- Digoxin
- Sympathomimetic amines
- Amrinone

d. Reducing cardiac remodeling – ACE inhibitors

e. Treatment of underlying cause such as HT, carditis, IHD and valvular heart disease

f. Correcting precipitating and aggravating factors such as anemia, thyrotoxicosis hypothyroidism, IE and arrhythmias

Q70. Describe acute coronary syndrome and its management.

The term acute coronary syndrome includes unstable angina and non-Q myocardial infarction (non-Q MI)

Unstable angina

Clinical features
- Ischemic cardiac chest pain – Nonpersistent, intermittent
- ST–T changes without acute ST elevation
- Normal CPK-MB and troponin

Non-Q MI

Clinical features
- As above, except CPK-MB or troponin is elevated

Pathogenesis
- Due to intermittent or incomplete coronary occlusion by a platelet thrombus

Treatment
- Aspirin, clopidogrel, β-blockers, statins, GpII/IIIa inhibitors

Q71. What are the contraindications for thrombolytic therapy in AMI?

- Severe uncontrolled HT (BP greater than 180/120 mmHg)
- Cerebrovascular thromboembolic event within two previous months
- History of intracranial hemorrhage
- Bleeding disorders
- History of peptic ulcer (with active bleeding)
- Prolonged cardiopulmonary resuscitation (CPR)

Q72. What lifestyle modifications will you recommend to hypertensive patients?

- Weight reduction (for overweight patients)
- Regular exercise

- No smoking
- Alcohol permitted only in moderation (24 oz beer or 8 oz wine or 2 oz 100% whisky/day)
- Salt intake less than 6 g/day
- Adequate potassium, calcium and magnesium in diet
- Low saturated fat and cholesterol intake

Q73. What is holiday heart syndrome?

- Supraventricular tachycardia (most commonly atrial fibrillation and flutter), following alcoholic binge (usually on holidays, hence the name)
- Usually short lived. No long-term treatment required.
- Digitalis and β-blockers effective
- Patients may develop withdrawal symptoms

Q74. Enumerate sites of coarctation of aorta.

- Postductal (most common; adult type)
- Preductal (infantile type)
- Juxta ductal
- Ascending aorta
- Descending aorta
- Abdominal aorta

Q75. Which congenital cardiac lesions are associated with coarctation of aorta?

- Bicuspid aortic valve
- Ventricular septal defect
- Patent ductus arteriosus

Note – Berry aneurysm(s) (circle of Willis) are associated with coarctation of aorta

Q76. What target BP is to be achieved on treatment?

- Less than 140/90 in patients without DM or renal failure
- Less than 130/80 in patients with DM or renal failure

Q77. Name cardioselective β-blockers.

- Atenolol
- Metoprolol
- Acebutolol
- Carvedilol
- Bisoprolol

Q78. Which β-blockers are associated with intrinsic sympathomimetic activity?

- Pindolol
- Acebutolol

Q79. What is Dressler's syndrome?

Dressler's syndrome, also known as postmyocardiotomy syndrome, occurs after a variable period (2–8 weeks) of an episode of AMI or open heart surgery. Presenting features are recurrent fever, chest pain, pericardial and pleural rub (in some). Patient may develop cardiac tamponade. The pathogenesis is thought to be myocardial necrosis inducing the formation of autoantibodies against myocardium. It is managed by aspirin, NSAIDs or steroids. Anticoagulants are avoided due to the risk of development of cardiac tamponade.

Q80. What is Marfan's syndrome?

It is an inherited autosomal dominant connective tissue disorder. Clinical features are long spidery fingers (arachnodactyly), arm span greater than height, saucer or funnel-shaped chest (pectus excavatum), scoliosis, pes planus, high arched palate, ectopic lens, aortic dilatation or dissection and MVP. Beta blockers are helpful in slowing down the dilatation of aortic root and for relief of symptoms.

Q81. What is Ortner's syndrome?

Ortner's syndrome is pressure over recurrent laryngeal nerve due to enlarged left atrium (in mitral stenosis) causing palsy and hoarseness of voice.

Q82. What is Romano–Ward syndrome?

It is inherited as an autosomal dominant disorder. Patient has congenital prolonged QT syndrome, which predisposes the patient to ventricular tachycardia, torsade de pointes, syncope and sudden death.

Q83. What is Brugada syndrome?

This is an inherited disorder seen in young men and is due to faulty sodium channel that predisposes the individual to fatal arrhythmias, such as ventricular tachycardia and ventricular fibrillation. These are prevented by inserting an implantable defibrillator. The ECG can provide clue as it shows right bundle branch block (RBBB) and raised ST–T segments with unusual morphology in V1–V3.

Q84. What are the indications of oxygen therapy?

- Acute attack of asthma
- Chronic obstructive pulmonary disease (COPD)
- Respiratory paralysis (central, peripheral)
- Acute respiratory distress syndrome (ARDS)
- Pulmonary edema
- Pneumonia
- Anaerobic infections
- High altitude

Q85. What are the untoward effects of O_2 therapy?

- Precipitation of CO_2 narcosis (when administered continuously in COPD patients)
- Respiratory tract irritation
- Progressive decrease in lung compliance
- Pulmonary edema
- Acute respiratory distress syndrome
- Retrolental fibrous dysplasia
- Blindness
- Bronchopulmonary dysplasia

Note – The last three occur in neonates

Q86. Enumerate features that suggest malignant pulmonary nodule in chest X-ray.

- Size greater than 3 cm
- Irregular borders
- Absence of calcification
- Age (greater than 40 years)
- History of smoking (current, past)

Q87. What are the poor prognostic features of pneumonia?

- Respiratory rate greater than 30/minute
- Low systolic (less than 90 mm Hg) and low diastolic BP (less than 60 mm Hg)
- Extra pulmonary involvement (meningitis)
- Elderly patient
- Alcoholic
- Absence of fever and leucocytosis
- Bacteremia (+ve blood culture)
- Pre-existing lung disease
- Nosocomial infection
- Immunodeficiency
- Congestive cardiac failure

Q88. What are the indications for pneumococcal vaccination?

- Elderly (above 65 years of age)
- Children less than 5 years of age with history of invasive pneumococcal disease
- Chronic obstructive pulmonary disease
- Diabetes mellitus, chronic liver disease, chronic renal failure (CRF), alcoholism
- Cerebrospinal fluid (CSF) leak (meningitis)
- HIV infection, immunodeficiency
- Malignancy (Hodgkin's disease, multiple myeloma)
- Postsplenectomy, splenic dysfunction, asplenia, immunosuppressive treatment and organ transplant

Q89. What are the causes of upper zone infiltrates and cavitation?

- Tuberculosis
- Fungal infection
- Nocardia
- Atypical pneumonia
- Atypical mycobacterial infection
- Actinomycosis
- Silicosis
- Pulmonary infarction

Q90. What are the common sources of pulmonary metastasis?

Malignancy of following organs

- Lung
- Breast
- Testes
- Kidney (hypernephroma)
- Bladder
- Thyroid
- Stomach
- Colon
- Rectum
- Pancreas
- Liver
- Melanoma
- Sarcoma

Q91. What are the causes of endobronchial metastasis?

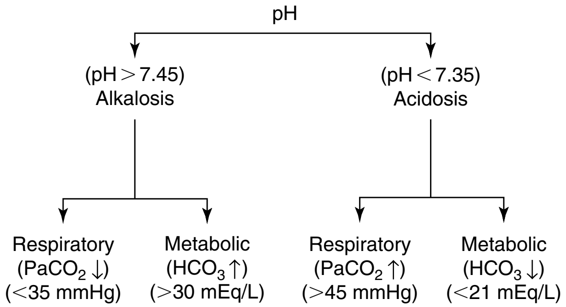
- Breast cancer
- Hypernephroma
- Melanoma

Q92. How will you assess prognosis of a COPD patient?

- No risk – Normal spirometry
- Mild risk – Forced expiratory volume in 1 second (FEV1) greater than 80% of

the predicted but less than normal plus symptoms
- Moderate risk – FEV1 50–80% of the predicted + symptoms
- High risk – FEV1 30–50% of the predicted + symptoms
- Very high risk – FEV1 less than 30–50% of the predicted + severe symptoms or respiratory failure or right heart failure.

Q93. How will you broadly analyze arterial blood gas (ABG) results?



Q94. How will you assess severity of bronchial asthma?

Severe asthma
- Tachycardia (pulse greater than 120 per minute)
- Tachypnea (respiratory rate greater than 25 per minute)
- Pulsus paradoxus
- Difficulty in speaking
- Peak flow rate less than 50% expected

Very severe asthma (life threatening)
Features
- Central cyanosis
- Exhausted, confused and drowsy
- Silent chest
- Bradycardia
- Peak flow cannot be recorded
- Arterial blood gases – Severe hypoxemia with CO_2 retention and low pH

Q95. Which conditions predispose to reactivation/reinfection of tuberculosis?

- Undernutrition
- Diabetes mellitus
- HIV infection
- Malignancies
- Chronic renal failure
- Immunosuppressive therapy
- Silicosis

Q96. What are the complications of pneumonia?

Local
- Parapneumonic effusion
- Empyema
- Cavitation (Staphylococcal, Klebsiella and aspiration pneumonia)
- Progressive pneumonia

Distant/systemic
- Pericarditis
- Endocarditis
- Atrial fibrillation
- Meningitis
- Arthritis

Q97. Classify antitubercular drugs.

- Bacteriostatic – Thiacetazone, para-aminosalicylic acid, ethambutol in low doses
- Bactericidal – All other antituberculosis drugs and ethambutol in higher doses (INH most potent bactericidal)
- Sterilizing – Rifampicin, pyrazinamide (act on persisters).

Q98. What are the different types of drug resistance of mycobacterium tuberculosis?

- Primary drug resistance
- Secondary or acquired drug resistance
- Transient drug resistance
- Multidrug resistance (MDR) – Isoniazid + rifampin resistance
- X-MDR (extensively MDR) – Isoniazid, rifampicin + other drugs (a fluroquinol and at least one of the injectable antitubercular drug)

Q99. What are the complications of BCG vaccination?

Common
- Secondary infection with regional lymphadenopathy
- Cold abscess involving regional lymph nodes

Rare
- Disseminated BCG infection
- Erythema nodosum
- Urticaria

Q100. Describe second-line anti-TB drugs.

Drug	Daily adult dose	Important side-effects
Streptomycin	1 g	Ototoxicity, renal toxicity
Para-amino salicylic acid	12 g	Diarrhea, hypersensitivity, hepatitis
Cycloserine	1 g	Depression, psychosis, convulsions, personality disorders
Thiacetazone	150 mg	Hepatitis, dermatitis
Ethionamide	1 g	Hepatitis
Kanamycin	1 g	Renal failure, deafness
Viomycin	1 g	Renal failure, deafness, vertigo
Capreomycin	1 g	Renal failure, deafness, vertigo

Q101. Describe directly observed treatment (DOT) of tuberculosis and its advantages.

Compliance is a major cause of treatment failure, emergence of drug resistance and spread of drug resistant infection in the contacts. Directly observed treatment is strongly recommended for noncompliant patients. Lack of money and personnel impede effective implementation of DOT programs.

Drug dosage (in mg/kg/day) – Administered thrice weekly

Isoniazid	10 mg
Rifampicin	10 mg (8–12)
Pyrazinamide	35 mg (30–40)
Ethambutol	30 mg (25–35)
Streptomycin	15 mg (12–18)

Q102. Describe prevention and treatment of hepatitis due to anti-TB drugs.

- Patients should be educated about clinical features of hepatitis and advised to report immediately when symptoms of hepatitis develop.
- Periodic LFT monitoring (once in 2 months even without symptoms) should be done.
- Pyrazinamide, rifampicin and INH should be omitted but streptomycin ethambutol can be continued along with ofloxacin. The patients should be followed up carefully.
- Viral hepatitis should be excluded.
- Standard treatment of hepatitis

Q103. Which antituberculosis drugs are safe during pregnancy?

Isonex (isoniazid)	Safe
Rifampicin	Very high doses are teratogenic in animal studies and risk of neonatal bleeding may be increased
Pyrazinamide	Can be given if potential benefit outweighs risk
Ethambutol	Safe
Streptomycin	Auditory or vestibular nerve damage. Better to avoid.

However, standard anti-TB treatment is usually allowed during pregnancy.

Q104. What is Caplan's syndrome?

- Seen in coal miners suffering from RA
- There is formation of necrotic granulomas in the lungs
- Presents with cough, breathlessness and hemoptysis
- Chest X-ray shows bilateral nodules
- Treatment is with steroids (must exclude TB)

Q105. What is Churg–Strauss syndrome?

It is a symptom complex of late onset bronchial asthma, vasculitis and eosinophilia. Lungs are affected because of asthma, and skin and peripheral nerves are affected due to vasculitis. Glomerulonephritis may also occur as a result of vasculitis though renal failure is rare. Antineutrophil cytoplasmic antibody is positive in 50% patients and response to steroids is good.

Q106. What is Loeffler's syndrome (pulmonary eosinophilia)?

Patient presents with cough and breathlessness. This is due to allergic infiltration of lungs by eosinophils (pulmonary eosinophilia). The common allergens are worm infestation such as *Ascaris lumbricoides* (the most common in India), strongyloides, ankylostoma, *Trichinella spiralis*, toxocara and *Fasciola hepatica*. Tropical eosinophilia is due to microfilaria in pulmonary capillaries. Some drugs, such as sulfonamides, hydralazine and nitrofurantoin can also act as allergens to cause the syndrome. Fungal infection (allergic bronchopulmonary aspergillosis), polyarteritis nodosa, cryptogenic eosinophilic pneumonia and Churg–Strauss syndrome are also other causes of pulmonary eosinophilia. For management, find out the cause and treat it. Deworming is recommended. In tropical eosinophilia, patients may be symptomless and may be detected either by elevated eosinophil count (absolute eosinophil count greater than 1500–2000) or by chest X-ray showing diffuse, fleeting, fan-shaped bilateral shadows. For tropical eosinophilia, diethylcarbamazine 100 mg tds for 3 weeks is recommended. In idiopathic cases with acute symptoms, steroids are useful.

Q107. What is Pancoast's syndrome?

This is due to Pancoast's tumor (apical lung cancer) that causes ipsilateral Horner's syndrome due to pressure over cervical sympathetic plexus (see Fig. 11.12). In some cases, there may be pressure over brachial plexus (C8–T1) giving rise to shoulder and arm pain. If tumor spreads medially, it can cause pressure over recurrent laryngeal nerve causing hoarseness of voice and a bovine cough.

Q108. What are the neurologic manifestations of B12 deficiency?

- Higher functions – Dementia, psychosis
- Cranial nerves – Optic atrophy
- *Pyramidal system – Spastic paraparesis
- *Posterior columns – Paresthesia, diminished vibration sense, diminished loss of proprioception
- Peripheral neuropathy

* Features of subacute combined degeneration

Q109. What are the common types of myopathies?

- Inflammatory (polymyositis, dermatomyositis; most commonly encountered)
- Muscular dystrophies (e.g. Duchenne's muscular dystrophy)
- Toxic/drugs (steroids, alcohol, zidovudine, statins)
- Endocrine (e.g. thyroid disorders – hypothyroidism, hyperthyroidism)
- Infections (AIDS, trichinosis)

Q110. What are the adverse neurological manifestations of alcohol?

- Peripheral sensory motor neuropathy
- Wernicke's encephalopathy
- Dementia (including Korsakoff's syndrome)
- Cerebellar ataxia
- Nerve compression (e.g. Saturday night palsy)
- Optic atrophy
- Myopathy
- Acute rhabdomyolysis

Wernicke's encephalopathy (triad)

- Extraocular muscle palsy + nystagmus
- Cerebellar ataxia
- Confusion

Korsakoff's psychosis

This condition is seen in chronic alcoholics due to vitamin B1 (thiamine) deficiency. Patients have reduced ability to acquire new memories, e.g. after Wernicke's encephalopathy, patient has gaps in his memory owing to retrograde amnesia and therefore confabulates to fill in the memory gaps. Donezepil may be helpful. Alcohol should be stopped completely and permanently, and patient should receive vitamin B1 supplements. (Thiamine hydrochloride 50 mg intravenously slowly, followed by 50 mg intramuscularly daily for 1 week and later 50–100 mg orally daily till full recovery).

Q111. Describe neurological manifestations of HIV infection.

- Aseptic meningitis
- Encephalopathy
- Myelopathy
- Acute demyelinating polyneuropathy

- Polyneuropathy
- Myopathy

Q112. What is Froin's syndrome and describe its causes?

Changes seen in CSF below the level of subarachnoid block are known as Froin's syndrome. These are

- Low CSF pressure
- Xanthochromia ± coagulum
- Raised proteins
- Normal sugar
- Queckenstedt test suggestive of block
- Cells normal or disproportionately low (albuminocytological dissociation)

Spinal subarachnoid block (total) is seen in

- Spinal tumors
- Chronic arachnoiditis
- Guillain-Barré syndrome (GBS)

Q113. What is subclavian steal syndrome?

Vertebral artery arises from the subclavian artery. When there is stenosis or occlusion of the subclavian artery, proximal to the origin of the vertebral artery and if there is increased demand of arm musculature during exercise, the demand is met by retrograde blood flow down the vertebral artery. It deprives blood supply to the brain stem resulting in symptoms of brain stem ischemia. This is termed as subclavian steal syndrome.

Q114. What is Ekbom's syndrome (restless leg syndrome)?

The syndrome is characterized by the patient's irresistible desire to move the legs when in bed. This may be associated with unpleasant leg sensations. It is invariably idiopathic. Known causes are iron deficiency anemia, CRF, DM, pregnancy and polyneuropathy. The exact pathogenesis is not clear. Dopamine agonists are the first drugs of choice; benzodiazepines (such as clonazepam 2–4 mg) given at bed time are also helpful.

Q115. Describe briefly the life cycle of human cysticercosis.

The adult worm (*Taenia solium*) is found only in man after eating undercooked pork containing cysticerci. Human cysticercosis occurs with ova entering the human stomach due to regurgitation from the person's own adult worm. In the stomach, larvae are liberated from the eggs, penetrate the intestinal mucosa and are carried in the blood to different parts of the body, particularly the skeletal muscles and brain where they develop and form cysticerci (0.5–1-cm cysts which contain the head of young worm). They remain in the tissues (muscles, brain) for life. Calcified cysts in muscles can be seen on X-ray and in brain by CT scan (see Fig. 11.42).

Q116. Describe lacunar stroke.

- Less common than thrombotic and embolic strokes
- It is due to occlusion of penetrating arterioles supplying deep brain substance
- Common sites – Basal ganglia, thalamus, internal capsule, brain stem
- Area of infarction less than 1 cm^3
- Onset usually gradual
- History of preceding transient ischemic attacks
- No alteration of mental state
- Usually pure motor or sensory stroke
  Clinical syndromes of lacunar infarction
  - ❑ Often asymptomatic
  - ❑ Pure motor hemiparesis
  - ❑ Pure sensory hemianesthesia
  - ❑ Ataxic hemiparesis
  - ❑ Dysarthria and clumsy hand syndrome
- Neurodeficit lasts for a short duration (24–48 hours)

Q117. What are the presenting features of giant cell arteritis?

- Headache
- Tenderness over temporal arteries and over scalp
- Fever, anorexia, malaise
- Myalgia and stiffness of muscles
- Arthralgia
- Diminution or loss of vision (sudden)
- Claudication of jaw
- Rarely patient may suffer from transient ischemic attack (TIA) or infarction of brain

Q118. Describe hyperviscosity syndrome

Normal range of plasma viscosity is 1.50–1.72 mPa/s. It gives same information as ESR and it is less affected by anemia. The PV is influenced by concentration of large plasma proteins and is elevated in same situations as the ESR. Hyperviscosity syndrome occurs when the viscosity rises so much that it impairs micro-circulation. Examples are elevated plasma components (usually immunoglobulins, e.g. multiple myeloma, Waldenström's macroglobulinemia), raised hematocrit with very high RBC count (polycythemia), a very high WBC count (acute or chronic leukemia)

Clinical features

CNS disturbances (confusion, fatigability), spontaneous bleeding (gastrointestinal, genitourinary), visual disturbances (retinopathy with engorged retinal veins, papilledema, exudates and hemorrhages). The typical visual disturbance is slow-flow retinopathy in which patient sees objects as if through a car windscreen is being splashed with rain water.

Hyperviscosity syndrome is an emergency and should be treated aggressively to reduce the viscosity. For example plasmapheresis in multiple myeloma and Waldenström's macroglobulinemia, venesection in polycythemia, leucapheresis in leukemia.

Q119. Describe drugs that worsen diseases of neuromuscular junction.

- Aminoglycosides
- Dilantin
- Quinidine
- Propranolol
- Lithium
- Tetracyclines
- Corticosteroids (acute effect in myasthenia gravis)
- Thyroid hormone
- Phenothiazines
- Lidocaine

Q120. What are the important causes of peripheral neuropathy?

- Diabetes mellitus
- Leprosy
- Alcohol
- Nutritional deficiency (e.g. B12)
- Drugs (e.g. INH)
- Toxins
- Guillain-Barré syndrome
- Nerve compression
- Nonmetastatic manifestation of cancer (e.g. carcinoma bronchus)
- Collagen vascular diseases (vasculitis, SLE)
- Uremia
- HIV, HCV, Lyme disease,
- Hereditary neuropathies
- Amyloidosis
- Acute intermittent porphyria
- Tumors

Q121. Describe measures to improve sleep.

- Follow regular sleep schedule
- Avoid daytime naps (exceptions elderly, shift-workers, narcolepsy patients)
- Regular pre-bedtime routine
- Ensure sleep-conducive environment – Quiet, dark place with comfortable temperature
- Regular exercise
- Relaxation techniques to reduce stress and worries
- Avoid caffeine-containing beverages, alcoholic drinks and smoking before bedtime
- Avoid diuretics late in the evening
- Work in bright light during daytime to help establish circadian rhythm

Q122. What are the common causes of vertigo?

Peripheral causes

- Vestibular neuronitis
- Drugs (aminoglycosides, frusemide, quinine, chloroquine)
- Meniere's disease
- Benign positional vertigo
- Acoustic neuroma
- Local trauma
- Panic attack

Central causes

- Basilar artery migraine
- Stroke
- Tumors
- Multiple sclerosis (MS)

Q123. Briefly describe Wilson's disease.

- It is an autosomal recessive metabolic disorder with failure to excrete copper in the bile at a rate essential to maintain zero balance of the metal.

- As biliary excretion of copper is reduced, it accumulates in liver cells. Once liver cells are saturated with copper, it spills over in plasma and gets deposited preferentially in basal ganglia, cornea and kidneys. Red blood cells are also affected causing hemolytic crisis.
- Salient features are cirrhosis of liver, bilateral degeneration of basal ganglia, Kayser–Fleischer rings and hemolytic crisis.
- Ceruloplasmin deficiency is not the cause but it is an important marker of the disease.
- Young patients usually present with cirrhosis of liver while older patients present with Parkinsonism and psychiatric disturbances.

Investigations

- There is an increase in free serum copper ($N = 8$–135 µg/dl) but serum ceruloplasmin is low ($N = 25$–45 mg/dl)
- Urinary copper excretion is high, usually greater than 100 µg/day ($N < 30$ µg/day).
- Hepatic copper concentration as seen in liver biopsy is increased by 50 µg/g of dry liver weight, while normal is less than 10 µg/g of dry liver weight.

Q124. How will you treat a case of Wilson's disease?

- Penicillamine is the drug of choice. It is started in a dose of 500 mg tds and may be stepped up gradually. It may take up to 6 months for the response; full recovery occurs gradually. On full recovery, dose can be reduced to half and continued indefinitely. Patients should receive pyridoxine 25 mg/day orally.
- Advised low-copper diet. Avoid high copper containing foods such as cashew nuts, vegetables, juices, cocoa, mushrooms, shellfish and beef liver.
- Trientine (600 mg tds) is used if penicillamine causes side-effects.
- Zinc acetate, 50 mg tds (orally) prevents accumulation of copper (not to be given along with penicillamine or trientine). It prevents systemic absorption of copper.
- Ammonium tetrahydromolybdate decreases copper absorption.

Q125. Describe Lambert–Eaton myasthenic syndrome.

- A rare disorder
- More common in middle aged men
- In majority, it is associated with small cell lung carcinoma (in some patients, no cancer is detected)
- Patient complains of weakness mostly in legs along with fatigue
- Autonomic disturbances may be present
- Ptosis is common
- Deep tendon jerks are absent or diminished
- Electromyogram shows incremental pattern
- Pathogenesis – Circulating antibodies to calcium channels diminish presynaptic release of acetylcholine at the neuromuscular junction.

Treatment

- Surgery of tumor
- Drug treatment – Guanidine, corticosteroids, immunosuppressive drugs, plasmapheresis, intravenous immunoglobulin and 3,4-diaminopyridine are used to enhance neuromuscular transmission

Q126. What is Alice in wonderland syndrome (Todd's syndrome)?

It is a type of psychiatric problem where the affected person has disturbance of his view of himself and has fast forwarding of intrapsychic time. This may be seen in some cases of epilepsy and migraine.

Q127. What is the difference between hemodialysis (HD) and hemofiltration (HF)?

In hemodialysis blood flows on one side of a semipermeable membrane while dialysis fluid flows on the other side of semipermeable membrane in the opposite direction solute transfer takes place by diffusion. Ultrafiltration is the removal of excess fluid by creating negative transmembrane pressure.

Disadvantages of HD are of problems with fistula such as thrombosis, stenosis, aneurysm; problem with temporary line, e.g. infection, blockage. With hemodialysis, some patients develop

Disequilibrium syndrome leading to hypotension and arrhythmias.

In hemofiltration, blood is filtred continuously across a high permeable synthetic membrane which allows removal of waste produces by a process of convection (not diffusion). The ultrafiltrate is replaced with an equal volume of replacement fluid. Hemofiltration takes longer time and is costlier than hemodialysis but hemodynamic instability is less common. Hence it is used in critically ill patients.

Q128. What is Marchiafava Bignami syndrome?

Marchiafava Bignami syndrome results from necrosis of corpus callosum due to alcohol. This results in left-hand deficit of constructional ability leading to left-hand agraphia, ataxia, mutism, gaze apraxia, dysarthria, paucity of vocal and facial expressions, epilepsy, blunting of consciousness and coma.

It is treated like Wernicke's encephalopathy with intravenous thiamine hydrochloride 50 mg, slowly followed by 50 mg intramuscularly for 1 week and later 50–100 mg orally daily.

Q129. What is Marchiafava Michel syndrome? (Paroxysmal nocturnal hemoglobinuria (PNH))

In patients with this disorder, RBCs (also neutrophils and platelets) become sensitive to complement-mediated lysis due to an inherited loss of surface glycosylphosphatidylinositol. This leads to chronic intravascular hemolysis (particularly at night). In addition, there is pancytopenia and increased tendency to thrombosis. Urinary hemosiderin is positive. Treatment includes anticoagulation and stem cell transplant, which may be curative.

Q130. What is Refsum's syndrome?

This syndrome comprises nerve deafness, night blindness (retinitis pigmentosa), polyneuropathy, cerebellar ataxia, anosmia and in some cases CMP. It is inherited as an autosomal disorder where there is accumulation of phytanic acid in the tissues. Diagnosis is confirmed by demonstrating raised levels of phytanic acid and albuminocytological dissociation in the CSF. It is treated by dietary restriction of foods rich in phytanic acid (dairy products, red meat, green leafy vegetables). Seriously ill patients require plasmapheresis.

Q131. What is Sturge–Weber syndrome?

The patient has port-wine stain on the face along with hemangioma of the brain on the same side as the port-wine stain, which causes contralateral focal fits. In addition, patient may develop hemiplegia and impairment of learning. Some patients may develop glaucoma. Diagnosis is confirmed by MRI of brain showing angioma. Treatment is symptomatic. Anticonvulsants are given for fits and glaucoma is treated if present.

Q132. What is Von Hippel–Lindau syndrome?

It is an inherited autosomal dominant disease. Clinically, it may present with diminution of vision or cerebellar ataxia. Patients are predisposed to bilateral renal cell carcinoma, pheochromocytoma, cerebellar and retinal hemangioblastomas.

Q133. What is Zellweger syndrome (cerebro-hepatorenal syndrome)?

It is a rare inherited autosomal recessive disorder. It is a severe form of infantile Refsum's syndrome with similar biochemical abnormalities. Presenting features are mental retardation, severe hypotonia, craniofacial deformities, cataracts, glaucoma, enlarged liver and renal cysts. There is high mortality. Patients die within few months of birth.

Q134. What are the different types of proteinuria?

- Normal – Less than 150 mg/day (less than 1+ by dipstick test); albumin less than 50% of the proteins excreted
- Tubular proteinuria – Less than 1 g/day, mainly of low-molecular weight proteins rather than albumin
- Glomerular proteinuria – Greater than 1 g/day, albumin and high-molecular weight proteins excreted
- Nephrotic range proteinuria – Greater than 3 g/day or greater than 3.5 g/1.73 m^2 body surface area

Q135. Define microalbuminuria. What are its important causes?

- Microalbuminuria is 40–300 mg daily urinary loss of albumin.

Causes

- Diabetes mellitus (microalbuminuria is an early manifestation of kidney involvement)
- Hypertension
- Obesity
- Acute myocardial infarction
- Severe physical exercise
- Excessive alcohol consumption
- Dyslipidemia

Q136. What are the urinary findings in prerenal azotemia?

- Low volume, concentrated urine
- Urine specific gravity greater than 1.015
- Urinary Na less than 20 mEq/l
- Fractional excretion of Na less than 0.01
- Increased urine osmolality

Q137. What are the urinary findings in acute tubular necrosis?

- Low urine volume, urine not concentrated
- Urine specific gravity less than 1010
- Urinary Na greater than 40 mEq/l
- Fractional excretion of Na greater than 2
- Urine osmolality less than 350 mOsm/kg

Q138. What risk factors contribute to acute renal failure (ARF) with the use of intravenous contrast media?

- Dehydration
- Multiple myeloma with renal insufficiency
- Elderly (above 60 years of age)
- Use of large volume of contrast medium (greater than 2 ml/kg)
- Multiple radiologic studies
- High uric acid (greater than 8.0 mg/dl)
- Serum creatinine greater than 1.5 mg/dl
- Albuminuria greater than 2+
- Hypertension

Q139. Describe urinary findings in primary glomerular diseases.

	Nephrotic	**Nephritic**	**Chronic renal disease**
Proteinuria	++++ (heavy)	++ (variable)	+ (mild)
Hematuria	+	++	+
Casts	Fatty	Fatty, RBC, WBC granular	Waxy, pigment, granular

Q140. Describe features of HIV nephropathy.

The commonest renal manifestations of HIV infection are

- Focal glomerulosclerosis seen on histopathology
- Heavy nephrotic range proteinuria
- Hyponatremia, hyperkalemia
- Mild to moderate HT
- Rapidly progressive renal failure

Renal transplantation is contraindicated in HIV +ve patients.

Q141. Which antibiotics will you choose in renal failure?

Contraindicated

- Tetracyclines
- Nitrofurantoin
- Nalidixic acid
- Bacitracin

No dose adjustment needed

- Erythromycin
- Rifampicin
- Doxycycline
- Oral vancomycin

All other antibiotics need dose adjustment according to guidelines provided with the drug information sheet.

Q142. What are the features that suggest CRF as against ARF?

- History of raised serum creatinine
- Small kidneys
- Band keratopathy
- Anemia (exception polycystic kidney disease)
- Hyperphosphatemia, hypocalcemia (may be present in ARF also)
- Fatigue
- Pruritus
- Nausea
- Nocturia
- Hypertension

Q143. How NSAIDs cause renal failure?

Nonsteroidal anti-inflammatory drugs can cause renal failure due to following mechanism.

In patients with reduced effective circulating blood volume (CCF, nephrotic syndrome, cirrhosis of liver), renal blood flow (RBF) and glomerular infiltration rate (GFR) are maintained by prostaglandins, especially PGE2. Nonsteroidal anti-inflammatory drugs by inhibiting PGE2 synthesis reduce GFR and RBF leading to renal failure.

Q144. What are the risk factors for NSAID-induced renal failure?

- Elderly
- Associated CCF, cirrhosis of liver, DM
- Patient taking diuretics, ACE inhibitors, β-blockers
- Dehydration
- Concurrent use of more than one NSAID

Q145. What are the types of urinary casts?

Types of cast	Interpretation
Hyaline	Nonspecific
Waxy	Advanced renal failure (indicate poor prognosis)
RBC	Pathognomonic of glomerulonephritis (other conditions rarely cause RBC casts)
WBC	Pyelonephritis and other causes of tubulointerstitial nephritis, occasionally proliferative glomerulonephritis
Granular	Glomerular or tubulointerstitial disorders, rarely dehydration, exercise
Pigment	ARF secondary to hemolysis or rhabdomyolysis, acute tubular necrosis plus jaundice
Fatty	Nephrotic syndrome (+++), tubulointerstitial disease (±)
Mixed	Proliferative GMN
Crystal	Metabolic disorder (e.g. hyperuricemia) may indicate the cause of calculi
Bacterial	Bacterial pyelonephritis
Epithelial	Acute tubular injury, glomerulonephritis, nephrotic syndrome
Pseudocasts	Clumped WBC, bacteria and artifacts.

Q146. What is Goodpasture's syndrome?

The syndrome is caused by anti-glomerular basement membrane antibodies binding to kidney basement membrane and alveolar basement membrane.

Goodpasture's syndrome has pulmonary and renal features. Patient presents with hemoptysis, diffuse pulmonary hemorrhage and/or hematuria (features of acute glomerulonephritis). Patients develop shock with fall in BP. Because of pulmonary hemorrhage, chest X-ray shows alveolar shadows. Kidney biopsy reveals crescentic glomerulonephritis. The diagnosis is confirmed by demonstrating anti-glomerular basement membrane antibodies in the blood.

Management

Patient should be treated in ICU for treatment of shock. Aggressive immunosuppressives, corticosteroids and plasmapheresis are used according to the severity. Recovery is possible with early treatment.

Q147. What is glycemic index? What is its importance?

Glycemic index is defined by the rapidity with which a carbohydrate increases blood sugar level. Glycemic index is a 2-hour plasma glucose curve after 50 g of carbohydrate in a given food is divided by the curve of 50 g of glucose in water.

Glucose, white bread and potatoes have higher glycemic index than whole grain cereals, brown bread and legumes. Patients with diabetes should be advised to cut down or avoid foods with high glycemic index.

Q148. Describe briefly empty sella syndrome.

It can be primary or secondary

Primary

Empty sella syndrome is enlarged sella turcica without any endocrine or visual disorder. It is due to congenital partial or complete absence of diaphragma sellae. This results in entry of CSF into the sella from subarachnoid space. Cerebrospinal fluid compresses the pituitary gland and expands the sella. Along with pituitary gland pituitary stalk is also compressed with the result that there is decreased transport of hypothalamic releasing hormones, especially the growth hormone (GH). Posterior pituitary gland is not affected. Patient has to be explained and reassured. No specific treatment is required.

Secondary

Destruction of pituitary by infarction, radiotherapy, surgery or ablation also leads to empty sella syndrome. Hormone replacement therapy may be required for secondary cases.

Q149. What are the different types of obesity?

- Android obesity – This is predominantly seen in men. There is excess deposition of fat over the waist region.
- Gynoid obesity – This is predominantly seen in women. There is excess deposition of fat over the region of buttocks and thighs
- Superior or truncal obesity – This is typically seen in Cushing's syndrome. Here, there is excess of fat deposition over upper part of trunk, neck and face but arms and legs are thin.
- Abdominal obesity – It is more common in Asian Indians than in other ethnic groups and is called visceral obesity as there is deposition of fat in the abdominal viscera and omentum. It is also called apple-shaped obesity (waist:hip ratio is 0.9 or greater) as against pear-shaped obesity (waist:hip ratio 0.8 or less). Pear shaped obesity is not harmful. Central obesity (apple shape) carries greater risk of developing complications, such as DM, HT, dyslipidemia and CAD (symptom complex of metabolic syndrome). The waist is measured at the narrowest circumference between lower costal margin and the iliac crest. The hip circumference is measured at a level that gives the maximal measurement of hip over the buttocks. Obesity is diagnosed if BMI is greater than 30 (refer Chapter 1 pg. 8).

Q150. Describe briefly diabetes insipidus (DI).

- **Definition**

Diabetes insipidus is excretion of large amounts of hypotonic but otherwise normal urine (hypotonic polyuria). Patient passes more than 3 l/day of urine (specific gravity less than 1.010 and osmolality less than 300 mOsm/kg) due to deficiency of ADH or vasopressin.

- **Etiopathogenesis**

There are three mechanisms

1. Neurogenic DI – Diminished secretion of ADH
2. Nephrogenic DI – Defective renal response to ADH
3. Dipsogenic D1 – Primary polydipsia (increased water intake)

1. Neurogenic DI

Patient presents with thirst, polydipsia and polyuria. Patient has intense thirst and passes large volume of urine (greater than 3 l per day) and urine osmolality is low (less than 300 mOsm/kg). It may be familial (autosomal dominant) or acquired.

Treatment

Desmopressin (long-acting analog of vasopressin) 10–20 µg, 1–2 times intranasally daily. Lypressin (another analog of vasopressin) is given in a dose of 2–4 units intranasally.

2. Nephrogenic DI

This is due to renal insensitivity to antidiuretic effect of arginine vasopressin (AVP). Patient has polyuria and passes hypotonic urine. Levels of AVP are normal or high.

It may be familial (X-linked) or acquired.

Treatment

Combination of thiazide diuretic with mild salt restriction is the treatment of choice. In addition treatment of the underlying cause is carried out

3. Dipsogenic DI

This occurs when osmotic threshold for thirst is paradoxically lower than for ADH secretion. This leads to chronic thirst, polydipsia and polyuria. Diagnostic triad is dilute urine, dilute plasma and suppressed ADH secretion. Attempt is made to reduce water intake by behavior modification.

Q151. Tell in brief control of GH secretion.

- The control of GH is by a dual system – Growth hormone-releasing hormone (GHRH) and an inhibitory hormone (GHRIH or somatostatin). Both GHRH and GHRIH are produced in the hypothalamus.
- The release of GH is pulsatile and is due to stimulation by GHRH and loss of somatostatin inhibition.
- Somatostatin is a tetradecapeptide, which in addition to its inhibitory effect on GH has inhibitory effect on release of other

hormones in the body, such as gastrin, glucagon, insulin, thyroid-stimulating hormone (TSH), gastric acid and pancreatic enzymes.

- The important effects of GH are mediated via an insulin-like growth factor (IGF-1), which is produced mainly in the liver.
- Somatostatin is produced in hypothalamus, delta cells of pancreas and GIT.

Q152. What are the causes of coma in hypopituitarism?

1. Hypoglycemic coma, because lack of GH, leads to increased sensitivity to insulin, resulting in hypoglycemia.
2. Diminished TSH secretion causes apathy and cold intolerance. Untreated severe hypopituitarism can progress to coma because of long-standing hypothyroidism.
3. Due to hypopituitarism, adrenocorticotropic hormone levels fall and this causes low cortisol levels. Cortisol is required for excretion of water, and thus, water intoxication takes places along with hyponatremia and hypokalemia, which cause coma.

Exposure to extreme cold, infection, trauma and sedatives are important precipitating factors.

Q153. Describe diagnostic criteria for gestational DM.

As per O'Sullivan–Mahan criteria, first screening of pregnant women is carried out between the 24th and 28th week of gestation by giving 50 g glucose orally at anytime of day or at the time of the last meal.

Measure venous plasma glucose after 1 hour, and if it is greater than or equal to 140 mg/day, gestational DM is suspected and a full glucose tolerance test (given below) is done to confirm the diagnosis.

- Oral glucose (100 g) is given after an overnight fast of at least 8 hours.
- Venous plasma glucose is measured after fasting and at 1, 2 and 3 hours after oral glucose.
- For a positive diagnosis, two or more of the following venous plasma glucose concentrations must be met.

Fasting $\geq$ 95 mg/dl
1 hour $\geq$ 180 mg/dl
2 hours $>$ 165 mg/dl
3 hours $\geq$ 140 mg/dl

Q154. Describe briefly porphyrias.

Porphyrias are rare genetic disorders. An error in the hem biosynthesis leads to toxic accumulation of porphobilinogen and porphyrin percussors. There are two types:

- Acute intermittent porphyria (AIP) – It is an autosomal dominant disorder, more commonly seen in women. Attacks are intermittent and may be precipitated by drugs. Urinary porphobilinogen is elevated during the attacks. Fecal porphyrins are normal. Skin is not affected.
- Variegate porphyria and hereditary coproporphyria – It is an autosomal dominant disorder. Cardinal feature is photosensitive blistering skin lesions. Clinical features –
  - ❑ During attacks, porphobilinogen is high and other metabolites may be detected in stools.
  - ❑ During an acute attack of porphyria, the patient may present with various features out of which presentation with acute abdomen (colicky pain in abdomen, vomiting with fever in some cases along with leucocytosis) should be kept in mind in the differential diagnosis of acute abdomen.
  - ❑ Other features of acute attack are HT, proteinuria, hypokalemia, hyponatremia, psychosis, convulsions, peripheral neuritis, paralysis and shock. Drugs, such as anesthetics (halothane, barbiturates), and alcohol may precipitate an attack of acute intermittent porphyria. These should be avoided in these patients.

Treatment

Acute attack

- Identify and stop trigger factors
- Intravenous fluids to correct electrolyte imbalance
- Intravenous hematin is widely accepted as the treatment of choice
- High-carbohydrate diet orally or by Ryle's tube

- Symptomatic treatment
- Pain relief – Morphine, codeine, aspirin
- Nausea/vomiting – Prochlorpromazine 12.5 mg intramuscular
- Convulsions – Diazepam
- Tachycardia and HT – Propranolol

Nonacute porphyrias

Porphyria cutanea tarda, erythropoietic protoporphyria – These manifest with cutaneous photosensitivity only.

Q155. Who discovered insulin?

Insulin was discovered in 1921 at the University of Toronto through joint research work of Frederick G Banting (a surgeon) and Charles H Best (a medical student) along with James B Collip (a biochemist), who developed an effective extraction procedure, and Professor JJR Macleod (Professor of physiology). Leonard Thomson, a young patient with diabetes at the Toronto General Hospital, was recipient of the first injection of insulin.

Q156. What are the characteristics of metabolic syndrome?

- Prediabetes or diabetes (insulin resistance – hyperinsulinemia)
- Central obesity (increased waist to hip ratio)
- Hypertension
- Dyslipidemia (↑ LDL ↑ TG, ↓ HDL ↑ Apo B)
- Impaired fibrinolysis
- Increased plasminogen activator inhibitor
- Raised C-reactive protein (proinflammatory state)

Note – Polycystic ovarian syndrome also has some features of metabolic syndrome

Q157. Describe insulins.

Type	Onset of action	Peak action	Duration of action
1. Rapid acting			
• Lispro (Humalog)	<30 minutes	30–90 minutes	3–5 hours
• Aspart (Novorapid)	<15 minutes	3 hours	3–5 hours
• Glulisine (Apidra)	10–20 minutes	30–90 minutes	4–6 hours
2. Short acting			
• Regular human insulin (HAI)	0.5–1 hour	2–4 hours	6–12 hours
3. Intermediate			
NPH*	1–2 hours	4–14 hours	10–24 hours
Lente*	1–3 hours	6–12 hours	12–24 hours
*Human insulins			
4. Long acting			
• Glargine (Lantus)§	1 hour	No peak	24 hours
• Detemir (Levemir)	1–4 hours	No peak	12–20 hours
• Ultralente (Human insulin)	4–8 hours	10–30 hours	18–36 hours
§Provides a flat, peakless 24–hour insulin coverage			
5. Mixtures (Premix)			
a. Human premix			
• 70% NPH + 30% regular	30 minutes	4–8 hours	16–24 hours
• 50% NPH + 50% regular	30 minutes	7–12 hours	16–24 hours
b. Lispro premix			
• 70% Protaminated lispro + 30% lispro	<30 minutes	Lispro 30–90 minutes	6–12 hours
	2–4 hours	Protamine lispro	12–24 hours
c. Aspart premix			
• 70% Protaminated aspart + 30% aspart§	<15 minutes	1–4 hours	12–24 hours
§B1Asp30 (Novo Mix.30)			

Q158. Describe oral hypoglycemic agents.

1. Insulin secretagogues

Sulfonylureas

a. 1st Generation

- Tolbutamide – Dose – 250 mg OD–1500 mg bd
- Chlorpropamide – Dose – 100 mg OD–750 mg/day
- Tolazamide – Dose – 100 mg OD–500 mg bd

    - Acetohexamide – Dose – 750 mg OD–750 mg bd
  - **b.** 2nd Generation
    - Glyburide – Dose – 1.25 mg OD to 10 mg bd
    - Glipizide – Dose – 2.5 mg to 20 mg bd
    - Glimepiride – Dose – 1–8 mg OD
  - **c.** Short-acting insulin secretagogues
    - Nateglinide – Dose – 60–120 mg tds with meals
    - Repaglinide – Dose – 0.5–4 mg tds with meals

2. Insulin sensitizers
   - **a.** Biguanides – Metformin – Dose – 500 mg OD to 1250 mg bd
   - **b.** Thiazolidinediones
     - Pioglitazone – Dose – 15–45 mg OD
     - Rosiglitazone – Dose – 2–8 mg OD
3. Intestinal enzyme – DPP-4 Inhibitors*
   - Sitagliptin – Dose – 50–200 mg OD
   - Vildagliptin – Dose – 50–200 mg OD

   *DDP-4 (Dipeptidyl-peptidase-4)
4. Alpha glucosidase inhibitors
   - Acarbose – Dose – 25–100 mg tds with meals
   - Miglitol – Dose – 25–100 mg tds with meals
   - Voligobose – Dose – 0.3 mg tds with meals

Q159. What are the indications for pharmacotherapy in obesity?

- Body mass index greater than 30
- Body mass index greater than 27 + co-morbidities
- Minimal response to 6 months of diet and lifestyle modification including exercise

Medications

Two types of appetite suppressants

- Those affecting catecholamine pathway. For example, phenteramine works as an anorexiant but is not used because of adverse side-effects.
- By affecting hypothalamus. For example, sibutramine (dose of 5–15 mg [10 mg] OD) is a β-1 adenoreceptor and 5-HT receptor antagonist. It reduces appetite and increases metabolic rate. It is the only anorexiant that is currently approved by Food and Drug Administration for long-term use.
- Orlistat (dose of 60–120 mg OD) inhibits intestinal lipase leading to reduction in fat absorption. Side effects – Insomnia, dry mouth, rise in BP and palpitation.
- Rimonabant (cannabinoid receptor antagonist) is useful for obesity and for nicotine deaddiction – Dose 20 mg OD. Recently, however, this drug has been withheld in some countries due to its side effects.

Q160. What factors are responsible for nonresponse to iron therapy in patients with iron deficiency anemia?

- Noncompliant patient
- Accompanying intake of H2 blockers or antacids causing achlorhydria
- Interaction with other drugs
- *H. pylori* infection
- Associated B12 or folic acid deficiency in addition to iron deficiency
- Worm infestation or malabsorption, e.g. hookworm infestation, giardiasis and tropical sprue
- Persistent blood loss (piles, peptic ulcer, gastritis and heavy menstrual loss) that cannot be compensated by iron intake

Q161. Describe briefly hemophilia.

Hemophilia is an X-linked inherited disorder of coagulation. Men are affected and women are carriers. Approximately two-thirds of the patients have positive family history. Factor VIII deficiency results in hemophilia A and factor IX deficiency leads to hemophilia B.

The cardinal feature of hemophilia is recurrent bleeding into joints and soft tissues. The symptoms start in childhood and continue throughout life. Bleeding into soft tissues of arms and legs can lead to compartment syndrome. Amongst joints, knee joint is most commonly involved. Patient should be treated at the earliest, otherwise the joint gets damaged due to the proliferation of synovial membrane and erosion of articular cartilage. Any trauma or operation leads to bleeding that does not stop until the deficient factor is replaced.

Laboratory diagnosis

- Normal prothrombin time
- Abnormal (prolonged) activated partial thromboplastin time (APTT) that gets corrected with pooled normal plasma
- Prolonged clotting time
- Normal bleeding time
- Diagnosis confirmed by demonstrating specific factor (VIII or IX) deficiency by the specific assay

Management

For mild to moderate hemophilia, main treatment is to take precautions to avoid trauma. If there is spontaneous bleeding, replacement of the factor is necessary. In severe hemophilia, patients get frequent spontaneous bleeding episodes. Treatment can be factor replacement during bleeding episode or factor replacement done as prophylactic measure. (given 2–3 times a week to maintain adequate factor level).

Q162. Describe the important features of disseminated intravascular coagulation (DIC).

In DIC, the coagulation process continues unrestricted, leading to excessive thrombus formation with consumptive coagulopathy.

Its causes are

- Obstetric complications, such as septic abortion, placental detachment, intrauterine fetal death
- Severe infection – Gram negative septicemia, falciparum malaria, septic shock, meningococcal infection
- Mismatch blood transfusion
- Malignancy – Cancer of breast, prostate, pancreas, lung
- Miscellaneous – Snake (viper) bite, scorpion bite, fat embolism, burns

In the early phase, there is consumptive coagulopathy followed by bleeding from various sites (skin, mucous membranes, oral, nasal, GI and GUT).

There is thrombocytopenia, prolonged PT and APTT and fibrinogen levels decrease; fibrin degradation products including D-dimer levels are elevated.

Management

- Treat in an ICU
- Correct/treat the triggering factors including termination of pregnancy
- Antibiotics
- Replace coagulation factors with cryoprecipitate, fresh frozen plasma (FFP), and factor VIII, replace fibrinogen
- Platelet concentrates; heparin if there are progressive thrombotic complications

Others that may benefit

- Antithrombin-III
- Activated protein C concentrates

Q163. What are the clinical manifestations of iron overload?

- Heart – Cardiomyopathy, arrhythmias
- Liver – Cirrhosis of liver, hepatoma
- Endocrines – Diabetes mellitus, hypogonadism, hypothyroidism
- Skin – Hyperpigmentation
- Joints – Chondrocalcinosis, arthritis, subchondral cysts, osteopenia

Q164. What are the laboratory findings of hemochromatosis?

- High serum iron (greater than 300 mg/dl)
- High serum transferrin saturation greater than 50% for women, greater than 60% for men
- High serum ferritin (greater than 1000 ng/ml; can be elevated in inflammatory disorders also)
- Hepatic iron content estimation (by high-intensity MRI or biopsy)
- Genetic study (testing for 282Y and H63D)

Q165. What are the indications for treatment with erythropoietin (EPO)?

- Anemia of CRF
- AIDS-related anemia
- Chemotherapy-related anemia
- Cancer-related anemia
- Preparation for autologous transfusion for surgery
- Myelodysplasia

- Anemia of prematurity
- Rheumatoid arthritis with anemia and low EPO levels

Q166. What are the side-effects of EPO?

- Headache
- Hypertension
- Edema
- Nausea
- Arthralgias
- Thrombosis

Q167. What are the causes of punctate basophilia?

- Chronic lead poisoning
- Severe anemia
- Beta thalassemia

Q168. In which conditions are target cells seen?

- Thalassemia
- Hemoglobinopathies
- Hyposplenism, postsplenectomy
- Chronic liver disease

Q169. In which conditions are Howell–Jolly bodies seen?

- Splenectomy, hypofunctioning spleen
- Megaloblastic anemia

Q170. In which conditions are Heinz bodies seen?

- Asplenia
- Thalassemia
- Chronic liver disease

Q171. What are the indications for parenteral iron therapy?

- Gastrointestinal intolerance
- Iron malabsorption
- Severe anemia in late pregnancy
- With EPO treatment in CRF

Q172. What are the laboratory diagnostic features of hemolytic anemia?

- Peripheral smear (spherocytes, target cells, fragmented RBC)
- Elevated LDH
- Increased indirect serum bilirubin with raised urinary urobilinogen
- Low serum haptoglobin
- Hemoglobulinuria
- Hemoglobinemia
- Hemosiderinuria
- Low serum hemopexin
- Hb electrophoresis (to determine abnormal Hb)
- Reduced RBC survival
- Osmotic fragility

Q173. What are the basic mechanisms of hereditary hemolytic anemias?

1. Membrane disorders
    - Congenital – Spherocytosis, elliptocytosis, stomatocytosis
    - Acquired – Hypophosphatemia, PNH, stomatocytosis
2. Hemoglobin abnormalities
    - Thalassemia major, sickle cell anemia, unstable hemoglobins, Hb C, E
3. Enzymatic defects
    - Glucose-6-phosphate dehydrogenase deficiency, pyruvate kinase deficiency, serum nucleotidase deficiency

Q174. What are the manifestations of sickle cell trait and disease?

- Hyposthenuria
- Hematuria
- Bacteriuria and pyelonephritis in pregnancy
- Bacteremia
- Splenic infarct at high altitude
- Pulmonary embolism
- Glaucoma
- Sudden death following exertion
- Avascular necrosis of bone

Q175. What are the trigger factors for sickling?

- Fever
- Low O_2 tension
- Acidosis
- Sluggish blood flow
- Associated Hb C and Hb D

Q176. How will you carry out (direct and indirect) Coombs' test?

- **Direct Coombs' test**

To patient's washed RBC, antiglobulin serum is added. Agglutination indicates the presence of either immunoglobulin (usually IgG) or C3, bound to RBC surface.

- **Indirect Coombs' test**

Patient's plasma is mixed with normal RBC and then incubated with antiglobulin. Presence of agglutination indicates alloantibody with cross reactivity.

Q177. Enumerate the differences between polycythemia vera and secondary polycythemia.

	Primary	Secondary
Splenomegaly	+	Absent
Total WBC count	↑	N
Platelet count	↑	N
Absolute basophil count	↑	N
Bone marrow	Panhyperplastic	Erythroid hyperplasia
Vitamin B12 level	↑	N
Erythropoietin level	↓	↑
Leucocyte alkaline phosphatase (ALP)	↑	N

Q178. Enumerate the causes of microangiopathic hemolytic anemia (fragmentation hemolysis).

- Thrombotic thrombocytopenic purpura
- Hemolytic uremic syndrome
- Eclampsia/pre-eclampsia
- Malignant HT
- Disseminated intravascular coagulation
- Scleroderma renal crisis
- Disseminated carcinomatosis
- Cavernous hemangioma

Q179. What are the causes of neutropenia?

Decreased production

- Drugs
- B12, folic acid deficiency
- Aplastic anemia
- Myelofibrosis
- Tumor invasion
- Infections – Malaria, tuberculosis, viral infections including viral hepatitis, leishmaniasis, AIDS, dengue fever

Decreased survival

- Systemic lupus erythematosus
- Splenic sequestration
- Drugs
- Autoimmune and isoimmune neutropenias

Q180. Name the common drugs that cause neutropenia

- Cytotoxic agents
- Indomethacin
- Phenacetin
- Acetaminophen
- Phenylbutazone
- Dipyrone
- Chloramphenicol
- Sulfonamides
- Penicillins
- Cephalosporins
- Phenytoin
- Antithyroid drugs
- Clozapine
- Chlorpropamide
- Captopril
- Cimetidine

Q181. What are the causes of acute lymphocytosis?

Usually due to viral infections.

- EBV (atypical lymphocytes seen in peripheral smear)
- Cytomegalovirus (atypical lymphocytes seen in peripheral smear)
- HIV
- Adenoviruses
- Rubella
- Herpes simplex type II
- Toxoplasma

Q182. What are the poor prognostic factors in Hodgkin's disease?

- Older age
- Lymphocyte depletion-type Hodgkin's disease
- Diffuse disease
- Large masses
- Disease in two or more extranodal sites
- T-cell phenotype
- Elevated LDH

Q183. Enumerate common tumor markers.

Common markers

- Alpha-fetoprotein – It is elevated in carcinoma liver, hepatitis, cirrhosis of liver and germ cell tumors. In pregnancy, it is elevated with fetal malformation.
- Carcinoembryonic antigen – It is elevated in malignant tumors of GIT, especially colorectal carcinoma, pancreatitis and cirrhosis of liver.
- CA15.3 – It is elevated in breast cancer and benign breast diseases.
- CA 19.9 – It is elevated in colorectal and pancreatic carcinomas.

  - CA 125 – It is elevated in carcinoma of ovary, uterus, breast and hepatocellular carcinoma. It is also elevated in cirrhosis of liver and peritonitis.
  - Human chorionic gonadotropin – It is elevated in germ cell tumors, pregnancy, choriocarcinoma and hydatidiform mole.
  - Placental ALP – It is elevated in seminoma, cancer and pregnancy
  - Neuron-specific enolase – It is elevated in neuroblastoma and small cell lung cancer.
  - Prostate specific antigen – It is a marker of prostate cancer but is also elevated in benign prostatic hypertrophy. Cancer prostate is suspected with high values.

Tumor markers may be helpful in diagnosis, but their real value is in monitoring the course of disease and the effectiveness of the treatment.

Q184. What are the plasma cell disorders?

- Multiple myeloma
- Heavy chain diseases
  - Gamma heavy chain disease
  - Alpha heavy chain disease
  - Mu heavy chain disease
- Waldenström's macroglobulinemia
- Monoclonal gammopathy of uncertain origin

Q185. Describe compatible blood group.

Recipient	Donor
AB	With all blood groups
B	With O and B groups
A	With O and A groups
O	With O only

Q186. What are the different types of blood products?

- Whole blood – Now rarely used
- Packed RBC (PRBC). One unit of RBC increases Hb by 1 g/dl and hematocrit by 3%
- Washed RBC for patients with severe reaction to plasma
- White blood cell depleted RBC for patients with nonhemolytic febrile transfusion reaction
- Fresh frozen plasma – An unconcentrated source of clotting factors without platelets. Used for patients with clotting factor deficiency and urgent warfarin effect reversal
- Cryoprecipitate – Concentrated FFP. One unit contains 250 mg of fibrinogen, 80 units factor VIII + Von Willebrand factor; used in DIC, cardiothoracic surgery, obstetric emergencies and uremic bleeding
- Granulocytes – Seldom used in sepsis with neutropenia (less than 500 WBC/mm^3)
- Rh immune globulin – To prevent maternal Rh antibody formation
- Platelet concentrates – Used for thrombocytopenia, with platelet dysfunction (due to drugs), with massive transfusions and preoperative with extracorporeal circulation. One platelet concentrate increases platelet count by 10,000/mm^3
- Irradiated blood products used to prevent graft versus host disease (GVHD)
- Blood substitutes (perfluorocarbon)

Q187. What are the complications of blood transfusion?

- Acute hemolytic transfusion reaction
- Delayed hemolytic transfusion reaction
- Febrile nonhemolytic transfusion reaction
- Allergic reactions
- Volume overload
- Acute lung injury
- Altered O_2 affinity
- Infectious complications – Malaria, yersinia, syphilis, hepatitis, HIV, cytomegalovirus, human T-lymphocytic virus 1 infection and Creutzfeldt–Jacob disease can also be transmitted

Q188. What are the complications of massive transfusion (greater than one blood volume of patient in 24 hours)?

- Dilutional thrombocytopenia
- Hypothermia
- Citrate and K toxicity especially in the presence of hypothermia

Q189. Describe briefly idiopathic thrombocytopenic purpura (ITP).

- Exact etiology is not known.
- In majority, antibodies against platelets are demonstrable; antigen is not known.
- Platelets coated with the antibody are sequestered in spleen, bone marrow, liver and other reticuloendothelial organs and destroyed.
- The antibody also inhibits production and release of platelets from bone marrow megakaryocytes.
- Acute ITP is common in children. It presents with upper respiratory tract infection followed by bleeding from gums and ecchymoses and purpura.
- Chronic ITP is more frequent in adults (affects women more than men). It is insidious in onset; in females, often presents with menorrhagia with severe anemia.
- Purpuric and ecchymotic spots are present all over the body along with bleeding gums, hematemesis and melena. Spleen is just palpable.
- Platelet count is less than 20,000/mm^3; bleeding time is prolonged but clotting time is normal. Hess surface tension test is positive. Bone marrow shows increased or normal megakaryocytes.

Management

- Acute ITP
  - ❑ Rest – platelet transfusion only if significant bleeding is present
  - ❑ Corticosteroids (prednisolone 1 mg/kg/day tapered to maintenance dose with response)
  - ❑ If corticosteroids fail, intravenous infusion of immunoglobulin 0.2–0.5 g/kg daily for 4–6 days gives rapid relief in two-third of patients
  - ❑ In emergency, plasmapheresis to remove antibody is life saving
- Chronic ITP
  - ❑ Corticosteroids are used as in acute ITP (prednisolone 1 mg/kg/day) and gradually the dose is tapered to a maintenance dose and continued for long period.
  - ❑ The new drug eltrombopag has been recommended for ITP. The recommended dose is 50 mg OD which can be increased to 75 mg OD after 2–3 weeks if the response is adequate. Cataract and thrombosis are important side effects.
  - ❑ Splenectomy – Gives dramatic benefit in 75% cases. Postsplenectomy, platelets shoot up and may exceed 700,000/mm^3 with the risk of thrombosis. Patients are given antiplatelet drugs and heparin prophylactically. Platelets return to normal gradually.
  - ❑ Presplenectomy vaccination against pneumococcus, meningococcus and hemophilus infection is necessary along with life-long penicillin prophylaxis.

Q190. Describe mechanism of bone loss with glucosteroid treatment and its prevention.

- Decreased absorption of calcium from GIT
- Increased urinary calcium excretion
- Increased parathyroid hormone (PTH) production, secondary to above two
- Inhibition of ovarian and testicular sex hormones
- Inhibition of bone formation
- Altered production of cytokines and growth factors

At all doses, corticosteroids induce osteoporosis, especially with a daily dose greater than 7.5 mg.

Osteoporosis parallels dose and duration of glucocorticoid therapy.

Prevention of glucocorticosteroid-induced osteoporosis (GCS treatment with 7.5 mg or more dose for more than 3 months)

- Calcium and vitamin D supplements, 1000 mg elemental calcium/day + vitamin D 400–800 IU/day
- Bisphosphonate, e.g. alendronate 35 mg per week
- Aerobic exercises
- Use smallest steroid dose for the shortest possible duration

Q191. Briefly describe abnormalities of serum calcium (Ca), serum phosphate (P04), ALP and PTH in bone disorders.

Bone disorders	Ca	PO4	ALP	PTH
Osteomalacia	Normal or ↓	↓	↑	↑
Osteoporosis	Normal	Normal	Normal*	Normal
Primary hyperpara-thyroidism	↑	Normal or ↓	Normal or ↑	↑
Hypopara-thyroidism	↓	↑	Normal	↓
CRF	Normal or ↓	Normal or ↑	Normal*	↑
Multiple myeloma	Normal or ↑	Normal or variable	Normal or ↑	Normal
Paget's disease	Normal	Normal	↑↑	Normal

*Increases if fractures present

Q192. What are the tests for the diagnosis of carpal tunnel syndrome and enumerate its causes?

Phalen's sign

Hold the wrists flexed at 90° for 1 minute. Appearance of symptoms of carpal tunnel is diagnostic.

Tinel's sign

Stroking median nerve at the wrist with a hammer produces tingling or sharp pain in the distribution of median nerve.

Causes

- Rheumatoid arthritis and other wrist arthritis
- Hypothyroidism, acromegaly, DM
- Pregnancy
- Amyloidosis
- Activities requiring repeated flexion and extension of the wrist
- Idiopathic

Q193. Describe in brief tropical sprue

1. Clinical features

Patients living in tropical countries (India, Sri Lanka, Malaysia, Indonesia and West Indies) present with malabsorption due to small intestinal disease in the absence of other intestinal diseases, such as helminthiasis. The clinical manifestations may resemble celiac disease. Its occurrence in tropics and occasional occurance in epidemics suggests possibility of infection with toxigenic *E. coli*.

Patient develops partial villous atrophy of jejunal mucosa.

Patient presents with diarrhea, abdominal distension, anorexia, loss of weight and fatigability. In some patients, the disease becomes chronic when patient develops megaloblastic anemia due to folic acid deficiency. Patient may also develop edema, ulcers and glossitis.

2. Investigations

- Xylose malabsorption
- Increased stool fat
- Megaloblastic anemia (vitamin B12 and folic acid levels are low)
- Low serum proteins and low serum albumin
- Diagnosis is confirmed by jejunal biopsy which shows partial villous atrophy

One should differentiate tropical sprue from celic disease, giardiasis, amebiasis and Crohn's disease

3. Principles of management

In severe diarrhea, treat dehydration and electrolyte disturbances.

Supplements of folic acid (5 mgm od) and vitamin B12 1000 ugm IM seem to reduce malabsorption and correct deficiencies

Oxytetracycline 500 mgm twice a day is given for 1 month to treat possible infection

Q194. What are COX-1 and COX-2 non steroidal anti-inflammatory drugs?

- Nonsteroidal anti-inflammatory drugs inhibit enzyme cyclo-oxygenase (COX) reducing conversion of arachidonic acid to prostaglandins.
- There are two types of COX (COX-1 and COX-2).
- Cox-1 is expressed constitutively and is expressed in almost all tissues. It is inhibited by all NSAIDs. COX-1 plays an important role in maintaining the integrity of gastroduodenal mucosa and in the maintenance of renal blood flow, especially in states of hypovolemia (cirrhosis, CCF, nephrotic syndrome).

- COX-2 is inducible and expressed during states of inflammation. Its expression is inhibited by corticosteroids. It modulates RBF, renal electrolytes and water balance.
- Inhibition of COX-1 leads to increased incidence of gastric ulcer, perforation and hemorrhage and renal failure
- Selective COX-2 inhibitors have lesser toxicity on gastroduodenal mucosa but are not free of renal toxicity.
- Cyclo-oxygenase-2-specific inhibitors do not retard platelet aggregation and may be associated with increased cardiovascular mortality.

Q195. What is Devic's Disease and how would you differentiate it from multiple sclerosis (MS)?

Devic's disease (neuromyelitis optica) is actually a type of multiple sclerosis (MS). There is demyelination of optic nerve, chiasma and spinal cord. The differences between the two are

1. while MS is relapsing, DS may be monophasic or relapsing;
2. MS is mild but DS is a severe disease;
3. while MRI is normal in DS, it shows periventricular white matter lesions in MS and
4. CSF-oligoclonal bands are absent in DS but present in MS.
5. There may be coexistent autoimmune disease in 50% cases of DS but such association is uncommon in MS.
6. As regards treatment, azathioprine is commonly used to treat DS and β-interferon is used to treat MS.

Q196. Describe in brief Guillain–Barré syndrome.

The onset is usually sudden. The patient develops symmetrical ascending muscle weakness. There are usually trigger factors, such as CMV, HIV, zoster, mycoplasma, EBV and *Campylobacter jejuni* infection. These pathogens result in antibody formation with demyelination or axonal damage. It progresses rapidly affecting lower limbs and then upper limbs, but all four limbs may be affected at the same time. The disease progresses for few weeks and then recovery starts. Proximal muscles are affected more, and in some serious cases, abdominal, respiratory muscles and cranial nerves (particularly facial nerve) are affected. There is absence of sensory signs. In some, patients autonomic nervous system is involved which causes BP changes and arrhythmias. The main risk is of respiratory muscle paralysis when patient would require ventilator support. Cerebrospinal fluid shows albumino-cytodisproportion (raised proteins with normal cells).

Patient has to be managed according to the presentation with ventilatory and hemodynamic support. The main treatment is with intravenous immunoglobulins or plasmapheresis. Corticosteroids are not indicated. Overall prognosis is good as large majority (more than 85%) make almost complete recovery. Mortality is significant (10%).

Variants of GB syndrome (rare)

- Descending type
- Miller–Fisher variant

Q197. Which rheumatic diseases are associated with Raynaud's phenomenon?

- Systemic sclerosis
- Systemic lupus erythematosus
- Mixed connective tissue disorder
- Antiphospholipid antibody syndrome
- Dermatomyositis
- Rheumatoid arthritis
- Sjögren's syndrome
- Carpal tunnel syndrome
- Systemic vasculitidis
- Cryoglobulinemia
- Reflex sympathetic dystrophic syndrome

Q198. Describe chondroitin sulfate (CS) and glucosamine sulfate (GS).

A number of drugs with chondro protective property have been developed. These drugs are CS and GS.

Chondroitin sulfate

- A natural component of cartilage (a glycosaminoglycan)
- Extracted from cow or shark cartilage or manufactured synthetically
- Used for treatment of osteoarthritis (OA)
- Reduces pain, joint inflammation and improves joint mobility after prolonged intake. Reduces need for NSAIDs
- Claimed to stimulate cartilage repair
- Dose 1200 mg/day PO in divided doses

Glucosamine sulfate

- A precursor of cartilage constituents
- Extracted from chitin (shells of crabs, oysters and shrimp)
- Used for the treatment of mild to moderate OA of knee; may not be useful for treating advanced OA of knee or OA of other joints
- Relieves pain, inflammation and improves mobility when taken over a long period. Reduces NSAID need
- May have disease modifying activity (evidence/opinions differ)
- Dose 500 mg TID
- Side effects – Patients having shellfish allergy may get allergic reaction, dyspepsia, headache, insomnia, nail changes and photosensitivity

Q199. What is a compartment syndrome?

- Compartment syndrome is due to increased tissue pressure within a tight facial compartment leading to tissue ischemia and later rhabdomyolysis. Anterior and posterior compartments of leg are common sites. Untreated, it can result in death.
- Causes – Trauma, ischemia, excessive physical activity
- Clinical features – Pain typically out of proportion to apparent injury. Other features, with advancing pathology, are paresthesia, paralysis, pallor and pulselessness.
- Diagnosis – Measuring compartmental pressure ($N < 20$ mm Hg)
- Definitive treatment – Fasciotomy

Q200. What is Lown–Ganong–Levine syndrome?

It is one of the types of pre-excitation syndrome with short PR interval (less than 0.12 seconds) and normal QRS complex (no delta waves as seen in WPW syndrome). Patient may get supraventricular tachycardia and complain of intermittent palpitations.

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Chapter 15

Emergencies

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HYPONATREMIA

1. **Definition** – Hyponatremia is defined as serum sodium (Na) less than 135 mEq/l due to excess of body water relative to body sodium.

   Clinical features are dependent upon the degree of hyponatremia and the rapidity of its development. Hyponatremia is commonly due to diuretics, diarrhea and conditions associated with water retention (congestive cardiac failure, nephrotic syndrome, liver cirrhosis and hypoproteinemia). Acute hyponatremia is less well tolerated than chronic hyponatremia.
2. **Clinical features** – Clinical manifestations are due to intracellular shift of water. The manifestations are
   - Headache
   - Nausea
   - Vomiting
   - Malaise
   - Muscle cramps
   - Lethargy
   - Confusion
   - Seizures
   - Stupor
   - Coma

   Seizures, stupor and coma usually develop with very low levels of serum Na (less than 115 mEq/l).
3. **Investigations** – Plasma osmolality, urinary sodium and urinary osmolality.
4. **Types** of hyponatremia and their causes
   a. Low extracellular fluid volume (ECF) volume with urinary Na greater than 20 mEq/l e.g. diuretics, Addison's disease, salt losing nephritis, osmotic diuresis, ketonuria and bicarbonaturia.
   b. Low ECF volume with urinary Na less than 10 mEq/l e.g. vomiting, diarrhea and third space loss.
   c. Normal ECF volume with urinary Na greater than 20 mEq/l e.g. glucocorticoid deficiency, hypothyroidism, pain, stress, drugs and syndrome of inappropriate anti-diuretic hormone (SIADH) secretion.
   d. Increased ECF volume with urinary Na less than 10 mEq/l e.g. nephrotic syndrome, cardiac failure and cirrhosis of liver.
   e. Extracellular fluid volume increased with urinary Na more than 20 mEq/l e.g. acute renal failure (ARF), chronic renal failure.
5. **Management** – Management depends upon the cause, the degree of hyponatremia and the patient's symptoms. Rapid correction of hyponatremia should be avoided as it carries the risk of neurologic complications.
   a. Mild hyponatremia
      i. Mild hyponatremia (serum Na greater than 120 mEq/l) does not warrant vigorous treatment.
      ii. If due to diuretics, diuretics should be stopped. Na and K replacement may sometimes be required.
      iii. If due to SIADH secretion correcting the underlying cause (see below) and fluid restriction are usually enough.
      iv. If hypovolemia is present, 0.9% intravenous (IV) saline is administered to correct both water and Na deficits.
      v. If hypervolemia is present, fluid restriction along with treatment of underlying cause is first tried. If this does not correct hyponatremia, a loop

diuretic, such as furosemide is given (sometimes with Na replacement). Resistant hyponatremia may need hemofiltration along with correction of hyponatremia with 0.9% IV saline.

   - **vi.** With euvolemia, underlying cause should be treated, e.g. adrenal insufficiency and diuretics. The syndrome of inappropriate antidiuretic hormone secretion is treated with fluid restriction (500 ml or less/day) along with a loop diuretic. Demeclocycline (300–600 mg, every 12 hours) is useful for persistent SIADH or if water restriction is not possible. Renal function should be monitored.
- **b.** Severe hyponatremia (serum Na less than 109 mEq/l)
   - **i.** If asymptomatic, patient is treated with fluid restriction, which is usually adequate.
   - **ii.** In symptomatic patients, IV hypertonic saline (3% = 513 mEq Na/l) is given cautiously. Frequent monitoring of serum Na is essential. The rate of correction of sodium should not be more than 1 mEq/hour or more than 10 mEq/l per 24 hours. The amount of Na deficit can be approximately estimated using the formula

     Na deficit = (140 − patient's serum Na in mEq/1) × total body water, where total body water (TBW) is – (TBW) = 0.6 × body weight (in kg)
   - **iii.** If the patient is unconscious or has convulsions, appropriate therapy is instituted.

Central pontine myelinolysis (osmotic demyelination syndrome) is demyelination affecting pons and other brain areas. It is due to too rapid correction of serum Na. Alcoholics and malnourished individuals are more susceptible to developing this complication.

Clinical manifestations are flaccid paralysis, dysarthria, dysphagia and locked-in syndrome. Full neurodeficit may take days to evolve.

Prevention – Rapid serum Na correction should be avoided and correction stopped at the earliest manifestation of neurodeficit. (Re)Inducing hyponatremia may prevent progression and permanent brain damage.

HYPERNATREMIA

1. **Definition** – Hypernatremia is defined as serum sodium greater than 145 mEq/l due to relative water deficit (relative to solute).

   Hypernatremia is a serious disorder and carries a mortality of 40–60% in adults. The elderly are particularly susceptible to hypernatremia due to impaired thirst response. Mechanisms and causes of hypernatremia are
   - **a.** Excessive loss of water relative to sodium loss e.g. vomiting, diarrhea, excessive sweating, burns, loop diuretics, osmotic diuresis and intrinsic renal disease
   - **b.** Water loss without sodium loss (total body Na normal), e.g. tachypnea, fever, sweating, diabetes insipidus and lack of access to water
   - **c.** Increased water and sodium content due to saline or sodium bicarbonate infusion, mineralocorticoid excess and total parenteral nutrition
2. **Clinical manifestations** – Clinical manifestations are due to cellular dehydration. These are
   - **a.** Thirst
   - **b.** Confusion
   - **c.** Neuromuscular excitability
   - **d.** Convulsions
   - **e.** Coma
3. **Treatment**
   - **a.** Total water deficit is calculated by the formula

     Free water deficit = TBW × [serum Na/140 − 1]

     where TBW (in liter) = body weight (in kg) × 0.6.
   - **b.** The aim of treatment is to correct the water deficit by
      - **i.** Oral hydration in a conscious patient
      - **ii.** Intravenous fluid replacement if hypernatremia is severe and if vomiting or mental obtundation prevent oral correction
   - **c.** Rate of correction
      - **i.** Correction within 24 hours if hypernatremia is of less than 24-hour duration

- **ii.** Correction in 48 hours if hypernatremia is of longer duration or of unknown duration
- **iii.** To avoid cerebral edema, the rate of reduction of plasma osmolality should not exceed 2 mOsm/l

Five percent dextrose is generally used for fluid replacement. Alternatively, 0.45% saline can be used in patients who are hypovolemic (e.g. diabetic ketoacidosis). In patients with hypernatremia with hypervolemia, the relative free water deficit is replaced with 5% dextrose, along with furosemide as furosemide if given alone may worsen hypernatremia.

HYPERKALEMIA

Serum K greater than 5.5 mEq/l defines hyperkalemia. Hyperkalemia can result from shift of K from intracellular to extracellular compartment, decreased K excretion by the kidneys or increased K intake. In most patients with hyperkalemia, an element of renal impairment is present. High K intake alone with normal renal function rarely causes hyperkalemia.

1. **Causes of shift of K from intracellular to extracellular compartment**
    - Metabolic acidosis
    - Hyperglycemia due to insulin deficiency (diabetic ketoacidosis)
    - Heavy exercise (especially if on nonselective beta blockers)
    - Acute tumor lysis, rhabdomyolysis
    - Digitalis intoxication
    - Intravascular hemolysis
    - Hyperkalemic periodic paralysis
2. **Causes of total body K excess**
    - Acute renal failure, (advanced) chronic renal failure
    - Rhabdomyolysis
    - Burns
    - Bleeding in soft tissues, GI bleeding
    - Adrenal insufficiency
3. **Drugs causing hyperkalemia**
    - Angiotensin-converting enzyme inhibitors
    - K-sparing diuretics
    - β blockers
    - Digitalis
    - Nonsteroidal anti-inflammatory drugs
    - Cyclosporine
    - Lithium
    - Heparin
    - Trimethoprim
4. **Clinical manifestations**

    May be asymptomatic until cardiac toxicity develops
    - Cardiac arrhythmias (nodal and ventricular)
    - Sudden cardiac death
    - Muscle weakness
    - Hypoventilation with involvement of respiratory muscles
5. **Investigations**
    - Serum K estimation
    - Electrocardiogram (ECG) – ECG changes do not always correlate with serum K levels. The changes seen with progressive rise in serum K are tall peaked T waves → prolonged PR interval and QRS duration → AV blocks → loss of p waves → ventricular fibrillation (VF) or cardiac asystole (Fig. 10.56)

      Additional investigations are required to assess the cause of hyperkalemia, e.g. arterial blood gas (ABG) and renal function
6. **Treatment**

    Immediate treatment – Hyperkalemia manifesting with ECG changes warrants urgent measures to lower serum K level. The measures include
    - 10–20 ml of 10% calcium gluconate (decreases membrane excitability) given over 5–10 minutes. Its action is transient (lasts for 20–30 minutes) and it may have to be repeated if the ECG changes do not revert within 5–10 minutes and until other measures become effective. It can be given more rapidly (5–10 ml over 2 minutes) if the ECG shows sine wave complexes or bradycardia. Caution is necessary when used in patients on digoxin, as hypokalemia related digitalis-induced arrhythmias may be precipitated.
    - 10–20 units of IV insulin along with 25–50 g of glucose. Insulin shifts K intracellularly and lowers K by 0.5–1.5 mEq/l within 30 minutes (hyperglycemic patients do not need glucose along with insulin).
    - 45 mEq of IV $NaHCO_3$ if acidosis is present. In patients with renal failure, this may cause volume overload. Its use is controversial.
    - β-adrenergic agonists to shift K intracellularly. Albuterol, 10–20 mg can be given over 30–60 minutes as continuous nebulization.

Measures to remove K from the body

- Loop and thiazide diuretics, alone or in combination
- Cation exchange resin (sodium polystyrene sulfonate – kayexalate), 25–50 g mixed with 100 ml of 10% sorbitol
- Dialysis – Indications for dialysis are renal failure and severe unresponsive hyperkalemia
- Long-term measures to avoid hyperkalemia – Low-K diet, diuretics, correction of acidosis, and avoiding offending drugs

Viva voce

Q1. What is pseudohyperkalemia?

- Pseudohyperkalemia is due to transient shift of intracellular K into intravascular compartment.
- Causes are repeated fist clenching, hemolysis, marked leukocytosis and marked thrombocytosis.
- Clue to its diagnosis is elevated serum K in an otherwise asymptomatic individual.

HYPOKALEMIA

Serum K level less than 3.5 mEq/l defines hypokalemia.

1. **Causes** – Though decreased intake of K can cause hypokalemia, the most common cause is gastrointestinal or renal loss of K.
   - **a.** Gastrointestinal loss – Chronic diarrhea, chronic laxative abuse, vomiting, nasogastric aspiration, clay pica and villous adenoma of colon
   - **b.** Renal loss
     - **i.** Diuretic therapy (furosemide, hydrochlorothiazide) and osmotic diuresis (glycosuria, mannitol)
     - **ii.** Cushing's syndrome, Conn's syndrome, secondary hyperaldosteronism, licorice
   - **c.** Intracellular shift of K – Total parenteral nutrition and enteral hypernutrition (due to glycogenesis), sympathetic stimulation (β-2 agonists, thyrotoxicosis), familial periodic paralysis, alkalosis, insulin
   - **d.** Drugs – Diuretics, laxatives, amphotericin, carbenicillin, high-dose penicillin and acute and chronic theophylline toxicity
2. **Clinical features** – Mild hypokalemia (3–3.5 mEq/l) is usually asymptomatic. Lower levels cause symptoms.
   - **a.** Neuromuscular
     - **i.** Muscle weakness, muscle paralysis including respiratory muscle paralysis, dysphagia and dysarthria
     - **ii.** Cramps, fasciculations, tetany
     - **iii.** Paresthesias
   - **b.** Gastrointestinal – Decreased intestinal motility, paralytic ileus, abdominal distension
   - **c.** Cardiovascular – Arrhythmias, heart blocks, hypotension and sudden death. Patients on digoxin are especially susceptible to develop arrhythmias, even with mild hypokalemia
   - **d.** Renal – Polyuria and polydipsia
3. **Investigations**
   - **a.** Electrolytes, ABG
   - **b.** Electrocardiogram shows depressed (sagging) ST segment, flattened T waves, prominent "U" waves, apparent QT prolongation (due to merging of T and U waves), arrhythmias and heart blocks
   - **c.** 24-hour urinary potassium excretion (excretion greater than 15 mEq/L suggests renal loss; refer metabolic alkalosis for more details)
4. **Treatment**
   - **a.** Potassium replacement
     - **i.** Oral replacement with potassium chloride 1 g tds is preferred for mild deficit. Tolerance to liquid KCl is however poor due to its bitter taste.
     - **ii.** For large deficits parenteral replacement is advised. (serum K less than 3 mEq/l is equal to deficit of 300 mEq; serum K less than 2.5 mEq is equal to deficit of 500 mEq),
     - **iii.** Correction should be with a slow K drip – 40 mEq of potassium chloride in 1 l dextrose or saline given at a maximum rate of 20 mEq/hour (10 mEq/hour preferred). Higher infusion rates or concentration need cardiac monitoring and administration via a central vein.

HYPOCALCEMIA

Hypocalcemia is serum Ca less than 8.4 mg/dl with normal serum albumin or ionized calcium less than 4.2 mg/dl. In the presence of low albumin, total serum Ca decreases. The value is corrected by adding 0.8 × difference between normal albumin (4.0 g/dl) and actual albumin, e.g. if serum albumin is 3.0 g/dl and serum calcium is 8.0 mg/dl, corrected serum Ca is $8.0 + (0.8 \times 4.0 - 3.0) = 8.8$ mg/dl, i.e. there is no hypocalcemia. Vitamin D deficiency, renal disease, malabsorption and hypoparathyroidism are some of the important causes of hypocalcemia.

1. **Clinical features** – Acute, moderate hypocalcemia causes symptoms. Patients with chronic hypocalcemia may have no symptoms attributable to low serum Ca.

   Symptoms – Symptoms are due to neuromuscular irritability. These are
   - Circumoral paresthesia, distal paresthesia
   - Tetany, carpopedal spasm, laryngospasm, confusion, convulsions
   - Bradycardia and heart failure (seen with acute severe hypocalcemia)

   Signs
   - **Trousseau's sign** – Precipitation of carpopedal spasm when blood pressure (BP) is raised by 20 mm above the systolic BP for 3 minutes
   - **Chvostek's sign** – Elicited by lightly tapping facial nerve just anterior to the external auditory meatus. There is twitching of facial muscles
2. **Investigations**
   - Diagnosis is confirmed by estimating serum calcium and ionic calcium
   - Other investigations – Serum phosphorous, parathormone (PTH), vitamin D, magnesium, BUN, creatinine and alkaline phosphatase
   - Electrocardiogram – Bradycardia, prolonged QT interval (see Fig. 10.59)
3. **Treatment** – Acute, symptomatic hypocalcemia needs prompt treatment.
   - If serum Mg is low it is corrected first by giving 2 g magnesium sulfate intravenously followed by a drip of 6 g magnesium sulfate in 1 l of IV fluid given over 24 hours because with low Mg, calcium replacement alone is ineffective
   - If serum Mg is not known, magnesium sulfate (2 g) can be given empirically (except in the presence of renal failure)
   - Calcium gluconate (20 cc of 10% equal to 2 g calcium) in 50–100 ml of 5% dextrose or normal saline is injected intravenously over 10–15 minutes, followed by a continuous drip of 60 ml of 10% calcium gluconate in 500 ml of 5% dextrose or normal saline at a rate adequate to maintain serum Ca between 9 and 10 mg/dl. Oral calcium therapy is started after gradual tapering off of IV calcium infusion; for patients on digoxin calcium infusion is to be given slowly with continuous ECG monitoring
   - Long-term management includes calcium and vitamin D supplements and treatment of underlying cause

Causes of Trousseau's sign

- Hypocalcemia
- Alkalosis
- Hypokalemia
- Hyperkalemia
- Hypomagnesemia

HYPERCALCEMIA

Serum calcium greater than 10.4 mg/dl or ionized Ca greater than 5.2 mg/dl defines hypercalcemia

1. **Causes**
   - Excessive bone resorption (bone metastasis, hyperparathyroidism, vitamin D toxicity, vitamin A toxicity, hyperthyroidism, immobilization)
   - Excessive GI absorption (vitamin D toxicity, sarcoidosis, milk–alkali syndrome)
   - Unknown mechanism (aluminum induced, myxedema, Addison's disease, Cushing's disease, lithium, aminophylline toxicity, thiazide diuretics)
   - Artifactual – Prolonged venous stasis during blood sample collection
   - Dehydration increases serum Ca levels.
   - Pancreatitis is a rare cause
2. **Clinical features**
   - Mild hypercalcemia can be asymptomatic

- Central nervous system (CNS) – Headache, convulsions, confusion, stupor, coma
- Gastrointestinal – Anorexia, vomiting, constipation
- Renal – Polyuria, renal calculi, renal failure
- Soft tissue calcification

3. Investigations

- Serum calcium, phosphorous, alkaline phosphatase, serum albumin
- Serum vitamin D – 25 (OH) D_3, serum PTH
- Electrocardiogram (shows shortening of QT interval and AV conduction blocks)
- Electrolytes

4. Treatment

- Correction of hypovolemia with IV 0.9% saline to achieve normal urine output and euvolemia. Intravenous fluids can then be continued with hypotonic solution to achieve a urine output of 100–150 ml/hour. Patient should be monitored for fluid overload, when a diuretic like furosemide is given
- Intravenous bisphosphonates – Pamidronate 60 mg IV is infused over 2–4 hours. Effect is seen in 2 days. Maximum effect is seen by 7 days, when it can be repeated if hypercalcemia is not corrected. Alternatively zoledronic acid (4 mg) IV is given over 15 or more minutes.

  Precautions – Hydration should be ensured before administering bisphosphonates. Lower dose should be used with renal insufficiency.
- Intravenous calcitonin 4–8 IU/kg IM or SC, 12 hourly. It acts within hours in majority of patients. Tachyphylaxis develops with its use over several days. Calcitonin has no serious side-effects and can be given safely with renal failure.
- Glucocorticoids are effective in hypercalcemia due to secondaries, vitamin D intoxication, sarcoidosis. Dose is 20–60 mg/d. Effect is seen after 5–10 days. The dose is reduced after serum calcium is stabilized.
- Dialysis – Low calcium dialysis is very effective and indicated with very high serum calcium levels (>16 mg/dl) and in patients with chronic renal failure.

  Measures for long term management. – Treat the underlying cause

METABOLIC ACIDOSIS

Metabolic acidosis is defined as primary reduction in HCO_3^-. Blood pH is usually less than 7.37; PCO_2 is reduced.

1. Classification

  a. Normal anion gap acidosis (AG = 10–12 mEq/l) is due to loss of bicarbonates secondary to diarrhea and renal tubular dysfunction (e.g. renal tubular acidosis).

  b. Increased anion gap acidosis is due to

    i. Over production of acids, e.g. lactic acidosis, diabetic ketoacidosis, starvation ketoacidosis, alcoholic ketoacidosis.

    ii. Ingestion of acids, e.g. salicylates, methanol, ethylene glycol, paraldehyde.

2. Clinical features – Mild acidosis can be asymptomatic. Symptoms develop with rapidly developing and severe acidosis. These are nausea, vomiting, lethargy and Kussmaul's breathing.

With severe acidosis, patients may develop hypotension, shock, ventricular arrhythmias and coma.

Chronic acidosis causes rickets, osteomalacia and osteoporosis.

3. Investigations

- Arterial blood gases, serum electrolytes
- BUN, serum creatinine
- Blood sugar
- Urinary ketones
- Serum lactic acid
- Toxin screen

4. Management

  a. Treatment consists mainly of identifying the cause and treating it. This is usually enough to correct the acidosis if serum HCO_3^- is greater than 15 mEq/l.

  b. Intravenous $NaHCO_3$ – Indications are:

    i. Normal anion gap acidosis due to bicarbonate loss or accumulation of inorganic acids.

    ii. In high anion gap acidosis, use of IV NaHCO is controversial as it does not improve the mortality, carries the risk of overshoot metabolic alkalosis, causes Na and water overload, hypokalemia and respiratory depression with CO_2 retention. Also it does not correct intracellular acidosis as $NaHCO_3$ does not diffuse across the cell membrane. Therefore, $NaHCO_3$ is administered only if pH is less than 7.0. It is given as a slow infusion, keeping a check on pH (target pH 7.20)

METABOLIC ALKALOSIS

Metabolic alkalosis is defined as primary increase in HCO_3^-. There may be compensatory increase in $PaCO_2$ and high or normal pH.

1. **Causes of metabolic alkalosis**
   - Gastrointestinal acid loss due to vomiting or nasogastric aspiration. The accompanying volume loss stimulates aldosterone secretion with reabsorption of HCO_3^- by the kidney.
   - Renal acid loss due to primary or secondary hyperaldosteronism; hypokalemia and hypomagnesemia, which stimulate K resorption with H^+ excretion; ingestion of licorice or carbenoxolone that inhibits conversion of cortisol to its less active metabolites.
   - Posthypercapnia correction (due to persistence of compensatory elevation of HCO_3^-), conversion of lactic acid and ketoacids to HCO_3, and $NaHCO_3$ loading.
   - Diuretics cause alkalosis secondary to ECF volume contraction.
   - Milk–alkali syndrome.
   - Carbohydrate refeeding after starvation (due to correction of starvation ketoacidosis), laxative abuse; antibiotics, such as carbenicillin, penicillin and ticarcillin (which contain nonresorbable anions, that decrease K and H^+ renal tubular resorption).

   Metabolic alkalosis may be chloride responsive or chloride nonresponsive.

   Causes of chloride responsive metabolic alkalosis are vomiting, gastric aspiration, diuretics (thiazide, loop diuretics) and alkalosis after correction of chronic hypercapnia.

   Causes of chloride nonresponsive alkalosis are hyperaldosteronism (primary, secondary), Cushing' syndrome, licorice, carbenoxolone, severe K depletion and rare disorders like Bartter's syndrome, Liddle syndrome, 11β- and 11α-hydroxylase deficiency.
2. **Clinical features** – Symptoms are present with severe alkalosis because alkalosis causes hypocalcemia. These are –
   - Headache
   - Lethargy
   - Tetany
   - Worsening of angina
   - Arrhythmias
   - Weakness (due to associated hypokalemia)
3. **Investigations**
   - Arterial blood gases
   - Serum electrolytes
   - Investigations to detect cause of alkalosis
   - Urinary Cl and K
4. **Diagnosis**
   - Urinary Cl less than 20 mEq/l – Cl-responsive metabolic alkalosis
   - Urinary Cl greater than 20 mEq/l – Cl-unresponsive metabolic alkalosis
   - Urinary K less than 30 mEq/l – Hypokalemic alkalosis e.g. laxative abuse
   - Urinary K greater than 30 mEq/l with normal BP e.g. Diuretic abuse, Bartter's syndrome
   - Urinary K greater than 30 mEq/l with hypertension e.g. hyperaldosteronism, mineralocorticoid excess, renovascular hypertension
5. **Management**
   - Treatment of underlying condition and correction of hypovolemia and hypokalemia.
   - For patients with chloride responsive alkalosis, 0.9% saline at 50–100 ml/hour or at a greater rate is given till urinary Cl is greater than 25 mEq/l and urinary pH is normal (Cl unresponsive patients do not respond to rehydration)
   - Hemofiltration or hemodialysis may be considered for severe metabolic alkalosis (pH greater than 7.6).
   - Acetazolamide (induces urinary HCO_3^- loss) 250 mg given oral or IV OD or BD, may help especially in patients with post hypercapnic alkalosis or volume overloaded patients with diuretic induced metabolic alkalosis.
   - Hydrochloric acid 0.1–0.2 normal solution (dose 0.1–0.2 mmol/kg/hour), can be given via central line. It however, needs frequent ABG and electrolyte monitoring.

RESPIRATORY ACIDOSIS

Respiratory acidosis is defined as primary increase in PCO_2. This may be accompanied by compensatory increase in HCO_3^-. pH is low. The CO_2 retention is secondary to hypoventilation (slow rate of respiration or low tidal volume). The causes of hypoventilation are impaired respiratory drive, peripheral neuromuscular transmission disorders, muscle weakness and obstructive, restrictive and parenchymal lung diseases.

1. **Clinical features** – Symptoms are due to high CO_2 levels, low pH and hypoxia. Symptoms depend upon the rapidity and degree of CO_2 retention.

   Symptoms due to acute rise of PCO_2 are –
   - Headache
   - Confusion
   - Drowsiness
   - Coma

   Symptoms secondary to slow rise of PCO_2
   - Slowly increasing PCO_2 levels are better tolerated
   - Disturbances of sleep, excessive day time sleepiness
   - Headache
   - Memory loss
   - Personality changes

   Signs
   - High-volume pulse
   - Tremors (flapping)
   - Gait disturbances
   - Myoclonic jerks
   - Mental obtundation
   - Depressed deep tendon reflexes
   - Papilledema
2. **Investigations**
   - Arterial blood gases estimation
   - Serum electrolytes
   - Alveolar–arterial (A–a) oxygen gradient (A–a oxygen gradient = Inspired PO_2 – [arterial PO_2 + $\frac{5}{4}$ arterial PCO_2]. A normal A–a oxygen gradient excludes pulmonary cause of CO_2 retention
3. **Treatment**
   - Treatment consists of providing adequate ventilation, either noninvasive or with endotracheal intubation.
   - With chronic CO_2 retention, the correction should be slow (over hours) to prevent posthypercapnic overshoot metabolic alkalosis, which may prove fatal.
   - Correction of electrolyte disturbances.
   - Administration of $NaHCO_3$ is generally not indicated, the exception being to improve response to β-agonists in a patient with severe bronchospasm.

RESPIRATORY ALKALOSIS

Defined as primary decrease in PCO_2, it may be accompanied by decreased HCO_3^-. The pH may be high or near normal. Respiratory alkalosis is usually the result of hyperventilation (increased rate or volume of respiration). Diagnosis is clinical.

1. **Causes of hyperventilation**
   - Hypoxia
   - Metabolic acidosis
   - Fever (increased metabolic demand)
   - Pain, anxiety
   - Central nervous system disorders
2. **Clinical features** – Depend upon the rapidity of fall of PCO_2
   - **a.** Acute drop in PCO_2
     - Light headedness
     - Confusion
     - Cramps
     - Circumoral paresthesias
     - Tetany
     - Syncope
   - **b.** Chronic change in PCO_2 is usually asymptomatic
3. **Investigations**
   - Arterial blood gases
   - Serum electrolytes
   - Serum calcium and serum phosphorus (a minor decrease in calcium and phosphorous may be present)
   - Increased A–a oxygen gradient (Normal A–a gradient <20 mm Hg) or low PO_2 is an indication to investigate the underlying cause
4. **Treatment**
   - Treatment is mainly directed at the underlying cause.
   - Treatment for respiratory alkalosis as such is usually not required as it is not a life-threatening condition
   - Increasing PCO_2 by the use of rebreathing paper bag may not be safe in patients with CNS disorders

POISONING

1. **General principles**
   - Poisoning and drug overdosage should always be suspected in patients with unexplained coma
   - Suicide and drug abuse account for majority of these cases
   - Details of drug(s) consumed and their dose are often unreliable, (understated) especially at the initial interrogation
   - Physical examination – Note vitals, (abnormal) odor and neurologic status including pupillary reaction and a systems review
2. **Investigations**
   - Hepatic and renal function tests
   - Arterial blood gases, electrolytes
   - Gastric aspirate, urine and stools for toxin identification
   - Abdominal X-ray
   - Electrocardiogram
   - Toxin screen
3. **Management** – All patients with suspected poisoning and due to drug overdosage even if asymptomatic should be observed in the hospital for at least 4 hours before considering discharge.

Symptomatic patients

a. **General measures**
   - **i.** Ensure patent air way; if necessary, intubate and ventilate
   - **ii.** Maintain BP with IV fluids. If necessary, use vasopressors, preferably dopamine except in patients with phenothiazine and tricyclic antidepressant overdosage
   - **iii.** Treat arrhythmias
   - **iv.** Administer antidote if available (see below)
   - **v.** Administer thiamine for suspected Wernicke's encephalopathy. Do not administer glucose without thiamine
   - **vi.** Institute measures to prevent continued absorption of the drug/poison.
     - ❑ Gastric lavage is not recommended as a routine (carried out for medico-legal purposes); If employed it should be performed within 1 hour of ingestion of the poison/drug. Gastric lavage is contraindicated with corrosive poisoning. It should be performed after endotracheal intubation in comatose patients and in patients with hydrocarbon poisoning
     - ❑ Activated charcoal is not useful in carbamate, ethanol, alkali, arsenic, heavy metal, cyanide, hydrocarbon, lithium, ferrous sulfate and mineral oil poisoning
     - ❑ Routine use of ipecac to induce vomiting and catharsis is no more advocated
     - ❑ Bowel irrigation
     - ❑ Endoscopic or surgical removal
   - **vii.** Measures to remove absorbed drug
     - ❑ Forced alkaline diuresis (for salicylate and barbiturate overdosage)
     - ❑ Hemodialysis or hemoperfusion
     - ❑ Chelation

Antidotes for drugs and poisons

Drug/toxin	Antidote
Organophosphates	Atropine, pralidoxime
Carbamates	Atropine; pralidoxime*
Aluminium phosphide	Magnesium sulfate (not a specific antidote)
Methemoglobinemia**	Methylene blue
Methanol	Ethanol, fomepizole
Cyanide	Amyl nitrite + Na nitrite + Na thiosulfate
Ethylene glycol	Ethanol, fomepizole
Heavy metals	Chelating agents (see below)
Snake bite	Snake antivenin
Scorpion bite	Scorpion antivenom (not very effective. Has to be given within minutes of the sting. No more advocated)
Acetaminophen	*N*-acetylcysteine
Anticholinergics	Physostigmine (use controversial)
Benzodiazepines	Flumazenil (use controversial)
Opioids	Naloxone
Tricyclic antidepressants	Sodium bicarbonate
Beta blockers	Glucagon

Ca-channel blockers	Calcium, intravenous insulin in high doses + intravenous glucose
Isoniazid	Pyridoxine
Digoxin	Digoxin specific Fab fragments
Hypoglycemic agents	Dextrose

*Efficacy doubtful
**Due to methemoglobin producing agents e.g. aniline dyes

Chelating agents

- Dimercaprol for antimony, arsenic, bismuth, chromium trioxide, copper, gold, mercury, nickel, tungsten and zinc
- Ethylenediaminetetraacetic acid (EDTA) for cadmium, lead and zinc
- Penicillamine for arsenic, copper, gold, lead, mercury, nickel and zinc
- Succimer for occupational exposure in adults to arsenic, bismuth, lead and mercury

Dosages

- Activated charcoal 1 g/kg BW – can be repeated every 4–6 hours
- For whole bowel irrigation – solution of (unabsorbable) polyethylene glycol with electrolytes at the rate of 1–2 l/hour for adults
- Alkaline diuresis – 5% dextrose with 25–35 mEq/l bicarbonate, IV at a rate that produces urine of pH greater than 8.0; K with every second or third bottle infusion or 20 mEq/l continuously, simultaneously
- Dimercaprol 10% in oil
    - ❑ 3–4 mg/kg deep intramuscular 4 hourly × 1 day
    - ❑ 2 mg/kg deep intramuscular 4 hourly × 1 day
    - ❑ 3 mg/kg deep intramuscular 6 hourly × 1 day
    - ❑ 3 mg/kg deep intramuscular, each 12 hours for 7–10 days (until recovery)
    - ❑ Edetate Ca disodium – 25–35 mg/kg, IV slowly (over 1 hour); 12 hourly for 5–7 days. Repeated after an interval of 7 days
    - ❑ Penicillamine – 20–30 mg/kg/day in three to four divided doses, starting with 250 mg QID. Maximum daily dose for adults – 2 g
    - ❑ Succimer – 10 mg/kg, 8 hourly for 5 days and then 10 mg/kg, each 12 hours for 14 days

Dialyzable toxins and drugs

Toxins	Drugs
Ethanol	Salicylates
Methyl alcohol	Barbiturates
Ethylene glycol	Sedatives
Lithium	Digoxin
	Quinine
	Theophylline
	Acetaminophen

b. Symptomatic treatment as necessary (e.g. high BP, abnormal blood sugar, renal failure)

c. After care

- Refer the patient to a psychiatrist or a center that deals with recreational drug addiction.
- Patients with suicidal tendency should be constantly under observation while hospitalized.

Organophosphorus compound poisoning

Organophosphorus compounds (OPs) are amongst the commonest agents used for suicidal purposes. Poisoning can also result from accidental, occupational, respiratory or skin exposure or when used in biowarfare (nerve gases). Organophosphorus compounds inhibit acetylcholinesterase with an increase in the concentration of acetylcholine in the autonomic nervous system, brain and somatic nervous system. There is excessive muscarinic and nicotinic activity.

1. **Diagnosis**
   History of OP ingestion or suggestive evidence.
2. **Clinical manifestations**
    - Muscarinic manifestations – Bradycardia, small pupils (pin point), blurred vision, bronchospasm, increased bronchial secretions (bronchorrhea), salivation, abdominal cramps, nausea, vomiting, diarrhea, urinary incontinence
    - Nicotinic manifestations – Fasciculations, muscle weakness, hypotension, respiratory paralysis
    - Central nervous system manifestations – Anxiety, slurred speech, convulsions, delirium, coma and respiratory depression
    - Other manifestations – Pulmonary edema, hyperglycemia, hyperamylasemia

Diagnosis is essentially clinical. Reduced RBC cholinesterase and plasma pseudocholinesterase levels confirm the diagnosis (levels less than 50% indicate poor prognosis).

3. **Investigations**
   - Chest X-ray, ECG (prolongation of QTc is a poor prognostic sign)
   - Arterial blood gases (ABG and ECG need to be monitored regularly)
4. **Management**
   - Maintain a clear airway. Intubate if necessary.
   - Decontaminate skin. Remove contaminated clothing. Wash the skin with soap and water.
   - Gastric lavage if the patient is seen within 1 hour of ingestion. Induction of vomiting is contraindicated.
   - Oral activated charcoal 50 g made into a slurry with water, and given every 6 hours (to prevent continued absorption)
   - Administer 1 mg preservative free atropine stat intravenously; observe for any adverse effects. Repeat 2 mg every 15 minutes until the patient is atropinized. Signs of atropinization are flushed face, dry mouth, dry secretions, tachycardia, dilated unresponsive pupils
   - Maintain atropinization for 24 hours or longer as required
   - With atropinization, patients may become restless and may need to be restrained.
   - Pralidoxime – It is not indicated for carbamate poisoning. Approximately 1–2 g in 100 ml of normal saline is given IV over 30 minutes. Pralidoxime controls fasciculations, counteracts muscle weakness and respiratory depression by reactivation of cholinesterase. Pralidoxime in the same dose is repeated every 6–12 hours during the first 24 hours or given as a continuous IV infusion. (Atropine does not reverse muscle weakness)
   - Phenytoin for control of convulsions.
   - Fresh RBC transfusion has been advocated but definite evidence of its benefit is lacking.
   - Ventilatory support for respiratory failure.
5. **Complications**
   - Delayed muscle weakness (1–2 weeks later)
   - Peripheral neuropathy

Causes of pinpoint pupils

- Organophosphate poisoning
- Opium poisoning
- Pontine hemorrhage

Barbiturate poisoning

Barbiturate poisoning is due to consumption of larger than therapeutic dose of barbiturates.

Clinical features depend upon the amount consumed and vary from drowsiness to coma and respiratory depression.

1. **Clinical presentation**

   Severe poisoning is characterized by
   - Deep coma
   - Slow respiration
   - Tachycardia, hypotension
   - Low body temperature
   - Absent deep tendon, gag and corneal reflexes. Light reflex may be lost due to asphyxia
   - Decerebrate posturing
2. **Investigations** – Serum barbiturate level to confirm the diagnosis and assess its severity.
3. **Treatment**
   - For mild poisoning, no specific treatment is necessary.
   - Gastric lavage is given only with recent ingestion of barbiturate (of less than 1 hour duration).
   - Respiratory and cardiac support.
   - Forced alkaline diuresis

   For adults
   - One liter of 5% dextrose with 150 mEq $NaHCO_3$ and 20–40 mEq K is given at the rate of 250 ml/hour (in children 2–3 ml/kg/hour). Urine pH is kept at ≥ 8.0; urine output is watched and if inadequate 40–80 mg frusemide IV is given as required.
   - Antibiotic(s) as necessary
   - Hemodialysis is indicated for very severe intoxication and renal failure

Salicylate poisoning (salicylism)

Ingestion of more than 150 mg/kg of salicylate can cause severe salicylate toxicity. Salicylate tablets may form bezoars in the stomach leading to prolonged absorption and toxicity. Oil of wintergreen (methyl salicylate) is the most concentrated form of salicylates. Chronic salicylate toxicity occurs with prolonged consumption of salicylates in high doses.

1. **Metabolic derangements**
   - Initially, respiratory alkalosis due to stimulation of the respiratory center.
   - Later metabolic acidosis because of mitochondrial poisoning with impaired cellular respiration.

- Salicylates independently cause acidosis, ketosis, low brain glucose levels and renal Na, K and water loss. There is increased respiratory loss of water due to hyperventilation.
- Hypoglycemia is common in children.

2. **Clinical features**
   - Fever
   - Nausea, vomiting
   - Dizziness, excitability
   - Tinnitus, diminished vision
   - Tachypnea, tachycardia
   - Convulsions, coma and respiratory failure are manifestations of severe life-threatening salicylate poisoning
3. **Investigations**
   - Serum salicylate level should be determined a few hours after ingestion; salicylate levels of greater than 70 mg/dl indicates moderate to severe poisoning; salicylate levels greater than 100 mg/dl is associated with severe poisoning
   - Serum electrolytes
   - Arterial blood gases
   - Blood sugar
   - Serum creatinine, BUN
   - Urine pH
   - Serum creatine phosphokinase
   - Urine for myoglobin, if rhabdomyolysis is suspected
4. **Treatment**
   - Gastric lavage with warm water and $NaHCO_3$ (if seen within 1 h of ingestion)
   - Activated charcoal, repeated every 4 hours (provided bowel sounds are present) till charcoal appears in the stools
   - Forced alkaline diuresis (as described under barbiturate poisoning) after correction of water and electrolyte disturbances
   - Correction of fluid and electrolyte disturbances; metabolic acidosis is treated with IV 7.5% sodium bicarbonate, to achieve urinary pH of $\geq$ 8.0
   - Hemodialysis is indicated with severe neurologic impairment, renal or respiratory insufficiency, serum salicylate greater than 100 mg/dl or uncorrectable acidosis
   - Symptomatic treatment –
     - ❑ Diazepam for seizures
     - ❑ IV calcium gluconate for tetany
     - ❑ Cold sponging for fever
     - ❑ Vitamin K for prolonged prothrombin time (PT)
     - ❑ Platelet transfusion for thrombocytopenia
     - ❑ Forced alkaline diuresis for rhabdomyolysis (to prevent renal failure)
   - Acetazolamide and respiratory depressants should be avoided

Methyl alcohol poisoning

1. **Sources of methyl alcohol** – Varnishes, paint removers, windshield washers, copy machine fluids and antifreeze solutions. It is also used as a solvent. Methyl alcohol poisoning often results from drinking adulterated ethyl alcohol (illicit liquor).
2. **Mechanism of toxicity** – Methyl alcohol is metabolized by alcohol dehydrogenase to formaldehyde and formic acid in the liver. Both the metabolites are toxic.
3. **Clinical manifestations**
   - Toxic manifestations appear after a variable period following ingestion
   - Early manifestations are nausea, vomiting, headache and vertigo.
   - Late manifestations are visual disturbances, metabolic acidosis, convulsions, coma, myocardial depression, bradycardia, shock and death.
   - Visual symptoms are diminished vision progressing to blindness. Ocular findings are dilated pupils, hyperemia and edema of optic discs.
4. **Investigations**
   - Arterial blood gases
   - Serum electrolytes
   - Hepatic and renal function tests
   - Blood methanol levels
   - Computed tomography (CT) scan shows bilateral putamen necrosis
5. **Treatment**
   - **a.** General measures
     - Gastric lavage
     - Correction of acidosis
     - Treatment of convulsions
     - Alkalization of urine
   - **b.** Specific treatment
     - Loading dose (15 mg/kg) of 5% solution of ethanol, followed by 2–3 ml/kg/hour orally (can be given IV also)
     - Hemodialysis indications – methanol levels greater than 50 mg/dl, high anion gap (A-G) acidosis, renal failure, visual symptoms

  - Folinic acid, IV 1 mg/kg (max. 50 mg) repeated every 4 hours (enhances conversion of formate to CO_2) for 24 hours
  - Methylpyrazole (inhibits alcohol dehydrogenase that metabolizes methyl alcohol to formaldehyde and formic acid) is considered antidote of choice but is expensive

Opioid poisoning

1. **Clinical manifestations**
   - Respiratory depression
   - Depressed consciousness
   - Small pupils
   - Hypotension
   - Bradycardia
   - Pulmonary edema

   Caveats
   - Pupils may be dilated due to hypoxia or acidosis
   - Heroin may be mixed with other substances, confusing the clinical picture
   - In individuals who smuggle heroin in their intestinal tract, there may be slow release of the poison
2. **Investigations**
   - Pulse oximetry
   - Arterial blood gases
   - Chest X-ray – If pulmonary symptoms are present
   - Abdominal X-ray (in smugglers)
3. **Treatment**
   - Emesis is contraindicated; gastric lavage can be carried out if the patient is seen within 1 hour of ingestion.
   - Whole-bowel irrigation (for smugglers who carry heroin in their intestines)
   - Maintain patent airway
   - Provide circulatory support
   - Naloxone HCl (specific antidote)

Dose – 2 mg, IV. Larger doses for a longer period may be required (for methadone, 24–48 hours; for levo-α-acetylmethadol, 72 hours) in which case IV infusion may be preferred. Alternative routes of administration are sublingual, via endotracheal tube or intranasal. If the patient does not respond to a total dose of 10 mg of naloxone, pure opioid poisoning is unlikely.

Acetaminophen poisoning

Acetaminophen is hepatotoxic. It depletes hepatic glutathione resulting in accumulation of its toxic metabolite *N*-acetyl-*p*-benzoquinone. Acetaminophen toxicity can be acute or chronic.

1. **Manifestations of acute overdose**
   - In the first 24 hours after ingestion – Anorexia, nausea, vomiting (due to gastritis) and sweating
   - Between 24 and 36 hours – Right upper abdominal pain and rise in serum glutamic oxaloacetics transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) levels; serum bilirubin and international normalized ratio (INR) increase with severe poisoning
   - Hepatic enzyme levels peak by 72–96 hours
   - After 5 days – Recovery starts unless there is progression to multiorgan failure
2. **Investigations**
   - Acetaminophen blood levels
   - Serum glutamic oxaloacetic transaminase, SGPT, serum bilirubin. Repeated daily for 3 days
   - Prothrombin time or INR. Repeated daily for 3 days
3. **Treatment of acute overdose**
   - General supportive measures
   - Oral activated charcoal
   - Oral acetylcysteine (mucomyst) is the specific antidote; It should be administered as early as possible as it is most effective when given within 8 hours of ingestion. Therefore, if the diagnosis of acetaminophen poisoning is most likely, acetylcysteine should be started even before acetaminophen blood level reports are available. Both oral and IV routes are effective. A blood level of greater than or equal to 150 μg/ml at 4 hours after ingestion of acetaminophen is an indication for acetylcysteine. With extended release acetaminophen poisoning blood levels are checked 4 and 8 hours after its ingestion

   Dose
   - Oral – Initial oral loading dose is 140 mg/kg, diluted 1:4 in fruit juice or carbonated beverage followed by 17 more doses of 70 mg/kg given at 4-hour intervals. Metachlopramide is given if patient vomits. If the patient vomits within 1 hour of dose administration, the same dose is repeated.

Oral charcoal and acetylcysteine can be given simultaneously.

- Intravenous acetylcysteine is advised for pregnant patients. It is given as an initial dose of 150 mg/kg dissolved in 200 ml of 5% dextrose in water over 1 hour, followed sequentially by 50 mg/kg dissolved in 500 ml of 5% dextrose in water over 4 hours, 100 mg/kg dissolved in 500 ml of 5% dextrose in water over 1 hour, 50 mg/kg dissolved in 500 ml of 5% dextrose in water over 4 hours and finally 100 mg/kg dissolved in 500 ml of 5% dextrose in water over 16 hours. Side effects are treated with diphenhydramine for urticaria, albuterol and corticosteroids for bronchospasm and diphenhydramine, ephedrine and corticosteroids for angioedema.

Markers of poor prognosis (as noted at 24–48 hours) are pH less than 7.3 after adequate resuscitation, INR greater than 3, serum creatinine greater than 2.6 mg/dl Grade III or Grade IV encephalopathy, hypoglycemia and thrombocytopenia.

Patients with fulminant hepatic failure may be treated with hepatic transplant.

Indications for hepatic transplantation

- Grade III or IV coma
- Serum creatinine greater than 3.4 mg/dl
- pH less than 7.3 after 24 hours
- Prothrombin time greater than 100 seconds (INR greater than 6.5)

On recovery from poisoning, liver returns to normal. Patients do not develop cirrhosis.

Aluminium phosphide poisoning

Aluminium phosphide is a fumigant pesticide used for grain preservation. It liberates toxic phosphine gas when it comes in contact with moisture.

Symptoms appear within 45 minutes to 1 hour of its ingestion. Toxic dose is 500 mg for a 70-kg adult.

Mortality is high (up to 100%). Death is due to cardiac toxicity and acute respiratory distress syndrome.

1. **Clinical manifestations**
   - Nausea, vomiting, diarrhea, abdominal and retrosternal discomfort
   - Hypotension, shock, cardiac arrhythmias, congestive cardiac failure, myocarditis, pericarditis
   - Cough, breathlessness, rhonchi, crepitations, respiratory failure
   - Jaundice, hepatic failure, acute renal failure, anxiety, apprehension, irritability, drowsiness progressing to coma
2. **Treatment**
   - Early diagnosis and treatment are important.
   - The main aim of treatment is to sustain life till the poison is excreted from the body.
     - ❑ Gastric lavage with MnO_4 (1:10,000) or magnesium sulfate to inactivate the poison.
     - ❑ Oral charcoal to reduce absorption of the poison.
     - ❑ Oral liquid antacid (60 ml/hour) to reduce gastric pH, gastric irritation and absorption of the poison.
     - ❑ No specific antidote is available. Magnesium sulfate (stabilizes cell membrane) is given in a dose of 1.0 g IV stat, followed by 1.0 g IV hourly for 3 hours and subsequently 1.0 g IV infusion for 3–5 days.
     - ❑ Adequate urine output and BP should be maintained.

Cyanide poisoning

1. **Sources** – Sodium cyanide, potassium cyanide, nitroprusside, prussic acid, wild cherry syrup, hydrocyanic acid and bitter almond oil.
2. **Clinical manifestations**
   - Headache, drowsiness, seizures, coma
   - Tachycardia, hypotension
   - Severe acidosis
   - Bitter almond odor to the breath
3. **Treatment** – Urgent and speedy action is essential.
   - Remove the patient from the source
   - Administer 100% O_2
   - Provide respiratory support
   - Specific therapy
     - ❑ Inhalation of 0.2 ml of amyl nitrite (1 ampoule) for 30 seconds of each min
     - ❑ Ten milliliter of 3% Na nitrate IV at 2.5–5.0 ml/minute followed by
     - ❑ Fifty milliliter of 25% Na thiosulfate IV at 2.5–5.0 mg/minute
     - ❑ Repeat above treatment with recurrence of symptoms
     - ❑ Hydroxycobalamin 5 g intravenously

Arsenic poisoning

Arsenic exists in elemental, inorganic and organic forms. Arsenic gas is most toxic. Inorganic compounds (trivalent > pentavalent) are more toxic than organic compounds. Elemental arsenic is nontoxic.

1. **Sources of exposure** – Pesticides, rodenticides, germicides, herbicides, timber preservatives, glass production etc. Ground water is often contaminated with arsenic compounds (chronic arsenic poisoning due to contaminated drinking water is encountered in West Bengal). Arsenic is often used for suicidal and homicidal purposes.
2. **Mechanism of toxicity** – Trivalent arsenic compounds inhibit pyruvate dehydrogenase complex. This results in reduced citric acid cycle activity and gluconeogenesis.
3. **Clinical features**
    - **a.** Acute poisoning
        - **i.** Gastrointestinal
            - Nausea
            - Vomiting
            - Initially, watery diarrhea. Later, in severe cases, bloody diarrhea
            - Severe abdominal pain
            - Electrolyte disturbances
        - **ii.** Cardiac
            - Hypotension, shock
            - Myocardial dysfunction
            - Prolongation of QT interval and T waves
            - Arrhythmias
        - **iii.** Central nervous system
            - Headache
            - Encephalopathy that progresses over days and manifests with delirium, convulsions and coma
            - Peripheral neuropathy
            - Others
                - ❑ Garlic like odor to breath may be present
                - ❑ Acute respiratory distress syndrome
                - ❑ Hemolysis
                - ❑ Rhabdomyolysis
                - ❑ Acute renal failure
                - ❑ Death occurs in 2–4 days
        - **iv.** Late manifestations (1–3 weeks later)
            - Sensorimotor peripheral neuropathy
            - Encephalopathy
            - Alopecia, cutaneous lesions
            - Mee's lines (1–2-mm wide transverse white bands)
    - **b.** Chronic poisoning
        - Myalgia, muscle weakness
        - Excessive salivation and lacrimation
        - Abdominal pain
        - Pruritus, hyperpigmentation, hypopigmentation
        - Hyperkeratosis of palms and soles
        - Peripheral neuropathy
        - Anemia, leucopenia, thrombocytopenia
        - Cardiac conduction abnormalities
4. **Diagnosis**
    - Urinary arsenic greater than 50 µg/l
    - Arsenic levels in hair, nails for chronic poisoning
5. **Treatment**
    - **a.** Acute poisoning
        - Decontamination
        - Chelation with dimercaprol (refer page 19)
        - Gastric lavage, whole bowel wash; charcoal not effective
        - Intravenous fluids, correction of electrolyte disturbances
        - Intravenous glucose
        - Other measures as per manifestations
    - **b.** Arsenic poisoning
        - Exchange transfusion
        - Hemodialysis for ARF

Mercury poisoning

1. **Sources**
    - Industrial – Manufacture of batteries, latex paints, polyvinyl chloride, fungicide, scientific instruments, gold mining and electrical industry
    - Medicinal – Antiseptics
    - Contamination of water due to industrial discharge
    - Inhalation of mercury vapors
2. **Mechanism of toxicity**. It binds to sulfhydryl groups present in cell membranes and enzymes
3. **Clinical manifestations**
    - **a.** Acute elemental Hg poisoning (due to inhalation of elemental Hg)
        - Cough, hemoptysis, cyanosis
        - Vomiting, diarrhea, metallic taste, salivation
        - Headache, encephalopathy, blurred vision
        - Respiratory involvement may be fatal
        - Interstitial lung disease may develop on recovery

- **b.** Acute inorganic poisoning
  - Abdominal pain, nausea, vomiting
  - Bloody diarrhea (with severe poisoning)
  - Hypotension
  - Acute renal failure
- **c.** Acute organic mercury poisoning – Manifestations are similar to acute inorganic poisoning
- **d.** Chronic poisoning
  - Dermatitis
  - Gingivitis, loosening of teeth
  - Stomatitis, salivation
  - Tremors, ataxia, dysarthria, diminished hearing, diminished vision, peripheral neuropathy
  - Insomnia, emotional lability, memory loss, irritability
  - Painful erythematous extremities, sweating
  - Tachycardia, hypertension

4. **Diagnosis**
   - Hg levels in whole blood, 24-hour urine and hair
   - Abdominal X-ray for detection of ingested mercury
5. **Treatment**
   - Acute poisoning
   - Prevent continued exposure
   - Chelation (dimercaprol, D-penicillamine refer page 19)
   - Gastric lavage, bowel wash with fluid containing milk or egg
   - Supportive treatment
   - O_2 and respiratory support
   - Surgical removal of entrapped Hg in the intestines or subcutaneous tissues

Lead poisoning

Lead poisoning is caused by scraping of leaded paint, ships, inhalation of aerosolized lead during scraping of walls before repainting, leaching (due to contact with acids, e.g. fruits, cola drinks) of lead from improperly lead-glazed ceramic ware, bullets lodged in body tissues, occupational exposure, medicinal herbs, fumes of leaded gasoline and recreational inhalation.

1. **Clinical manifestations**
   - Acute poisoning in children manifests with vomiting, seizures, ataxia, altered state of consciousness and coma due to cerebral edema. Seizures can be intractable.
   - Chronic poisoning in children manifests with abdominal pain, anemia, mental retardation, convulsions and behavioral disorders.
   - Chronic poisoning in adults manifests with headache, abdominal pain, personality changes, neuropathy and anemia. Inhalation of leaded gasoline can cause psychosis.
2. **Investigations**
   - Complete blood count (CBC) (including peripheral smear for basophilic stippling)
   - Serum electrolytes
   - BUN, creatinine
   - Blood sugar
   - Serum lead levels (toxic level greater than 10 μg/dl)
   - Abdominal X-ray (for lead particles)
   - X-ray of long bones in children for chronic poisoning (shows metaphyseal lead bands)
   - Edetate Ca disodium test is no more done
3. **Treatment**
   - Eliminate the source of lead poisoning
   - If abdominal X-ray shows lead in GIT, whole bowel irrigation with ethylene glycol (2 liters/hour for adults, 25–40 ml/kg/hour for children) is given until the X-ray shows absence of lead.
   - Bullets lodged in soft tissues may need surgical removal.
   - All neurologically symptomatic patients and children with blood level greater than 70 μg/dl should be hospitalized in an ICU.
   - Chelation with succimer, $CaNa_2$ EDTA or dimercaprol (BAL) (refer page 19)

Indications for chelation

- Adults with symptoms of poisoning and blood lead level greater than 70 μg/dl
- Children with encephalopathy or blood lead level greater than 45 μg/dl
- Multiple chelations over long periods may be required for chronic poisoning

Iron poisoning

Iron poisoning is an important cause of death in children.

1. **Effects**

   Iron is toxic to GIT, cardiovascular system and CNS. It interferes with oxidative phosphorylation leading to metabolic acidosis, formation of free radicals, acts as an oxidizer and generates H^+ ions and causes coagulopathy.

2. **Clinical features**
   - Stage 1 (within 6 hours) – Vomiting, diarrhea and abdominal pain. With severe poisoning, tachycardia, hypotension, tachypnea, acidosis and coma. Shock and coma within 6 hours is associated with high mortality
   - Stage 2 (6–48 hours) – Asymptomatic stage
   - Stage 3 – CNS toxicity, coagulation abnormalities and metabolic acidosis
   - Stage 4 (2–5 days) – Hepatic failure, hypoglycemia and coagulopathy
   - Stage 5 (2–5 weeks) – Pyloric or duodenal stricture
3. **Investigations**
   - Abdominal X-ray to detect tablets or iron concretions
   - Serum iron
   - Electrolytes
   - Blood pH
   - Liver function tests (LFT), serum creatinine, BUN, coagulation profile
4. **Treatment**
   - If no symptoms appear within 6 hours of ingestion, development of severe toxicity is unlikely.
   - All symptomatic patients should be hospitalized.
   - If abdominal X-ray shows iron tablets, whole bowel irrigation with polyethylene glycol (1–2 l/hour for adults and 24–40 ml/kg/hour for children) is given till the X-ray shows absence of iron in GIT.
   - Mixed poisoning is treated with oral charcoal.
   - For patients with severe poisoning (metabolic acidosis, shock, severe gastroenteritis, serum iron greater than 500 µg/dl), IV desferrioxamine is given at the rate of 15 mg/kg/hour. Intravenous desferrioxamine can cause hypotension which is treated with IV hydration.
   - Supportive treatment is given as per manifestations

Carbon monoxide poisoning

1. **Introduction**

   Carbon monoxide (CO) poisoning can result from house fires, improperly ventilated automobiles, closed garage with running automobile engine, furnaces, kerosene heaters and wood or charcoal burning stoves.

   Carbon monoxide binds to Hb displacing O_2, shifts the O_2 dissociation curve to left and inhibits mitochondrial respiration.

   Diagnosis is circumstantial. Carbon monoxide blood levels can be measured. Spectroscopic examination of blood for carboxyhemoglobin is confirmatory.
2. **Clinical features** correspond with blood carboxyhemoglobin levels
   - Levels 10–20% – Headache, nausea
   - Levels greater than 20% – Lack of concentration, impaired judgment and weakness
   - Levels greater than 30% – Chest pain (if patient has coronary artery disease [CAD]), dyspnea on exertion and confusion
   - Higher levels (greater than 60%) cause unconsciousness, convulsions, hypotension, respiratory failure and death.
   - Carbon monoxide poisoning produces characteristic cherry red color of the skin.
3. **Treatment**
   - Patient should be immediately removed from the environment and given mouth-to-mouth respiration.
   - 100% O_2, is administered as early as possible via oro-nasal mask. Endotracheal intubation may be necessary.
   - Treatment of cerebral edema (refer to treatment of raised intracranial pressure [ICP]).
   - Hyperbaric O_2 is quicker in removing CO. It is indicated with life-threatening cardiorespiratory complications, altered consciousness, continuous chest pain, pregnancy and carboxyhemoglobin level of greater than 25%. However, its efficacy has not been proven conclusively.
   - Maintain fluid and electrolyte balance.

Caustic ingestion

Strong acids and alkalies are caustic. They burn the GI tissues. Acids cause coagulative necrosis and form an eschar that prevents further tissue damage. Alkalies cause rapid liquefaction necrosis of tissues. There is no eschar formation and therefore damage continues until the alkali is neutralized or diluted. Acids damage stomach more than the esophagus while alkalies tend to damage esophagus more than the stomach. Both esophagus and stomach are damaged when large quantities are ingested.

1. **Clinical features**
   - Drooling
   - Dysphagia
   - Bleeding (oral, throat, chest, abdomen)
   - Cough
   - Dyspnea, stridor
   - Mediastinitis secondary to esophageal perforation (symptoms – fever, tachypnea, chest pain, tachycardia, shock)
   - Peritonitis secondary to gastric perforation. It can be an immediate or a delayed complication.
   - Esophageal stricture is a late complication

Caution – Oral mucosa may show little or no burns though the esophagus and stomach are severely affected. Only endoscopy can define the degree of involvement of esophagus and stomach following caustic ingestion.

2. **Treatment**
   - Activated charcoal, gastric lavage and emesis are contraindicated.
   - Attempts at neutralizing alkali or acid are not advised.
   - Oral fluids should be started as soon as tolerated.
   - Esophageal and gastric perforations are treated with antibiotics and surgery.
   - Corticosteroids are not to be used.
   - For esophageal stricture, dilatation or esophageal bypass by colonic interposition is required.

Hydrocarbon poisoning (gasoline, kerosene, mineral oil, paint thinners, etc.)

1. **Introduction**

   Ingestion of hydrocarbons causes severe aspiration pneumonitis, especially with low-viscosity hydrocarbons.

   Ingestion of large amounts, especially of halogenated hydrocarbons (e.g. carbon tetrachloride, trichloroethylene) can cause CNS toxicity and hepatotoxicity.

   Recreational inhalation of halogenated hydrocarbons (paints, solvents, cleaning sprays, gasoline, fluorocarbons) causes euphoria, increases sensitivity of the heart to catecholamines, sometimes resulting in fatal ventricular arrhythmias.
2. **Clinical features**
   - Breath or clothes may smell of hydrocarbon or hands may be stained with paint
   - Cough, choking
   - Vomiting
   - Breath holding and cyanosis in young children
   - Burning in stomach
   - Aspiration pneumonia
   - Lethargy, coma, convulsions with inhalation of large amounts
   - Cardiac arrhythmias
3. **Investigations**
   - Chest X-ray
   - Arterial blood gases
4. **Treatment**
   - Remove contaminated clothing
   - Supportive treatment of pneumonitis
   - Antibiotics and corticosteroids – Not indicated
   - Gastric lavage – Contraindicated.
   - Oral charcoal – Not advocated.

Snake bite

Sea snakes, cobra, Russell's viper, saw-scaled viper, green pit viper, elapid and krait are common poisonous snakes. Clinical manifestations and their intensity vary with each snake.

1. **Clinical manifestations**
   - **a.** At the bite site
     - Fang marks
     - Swelling – Viper > cobra > krait
     - Pain
     - Swelling, blister formation, bleeding – Severe with viper bite
     - Tissue necrosis
   - **b.** Others
     - Muscle pain, stiffness, weakness, myoglobinuria and ARF with sea-snake bite
     - Hyperkalemia
     - Disseminated intravascular coagulation (DIC), defibrination with hemorrhagic tendency – Bleeding from various sites (Russell's viper)
     - Shock, hemoglobinuria
     - Lassitude, hypersomnia, limb paralysis, ptosis, respiratory paralysis (cobra, krait)
     - Nausea, vomiting
     - Local infection (viper)

   Death is due to shock, respiratory renal failure.
2. **Treatment**
   - **a.** First aid
     - Reassure the patient

- Immobilize the affected part in functional position with a splint or a crepe bandage, which should not be too tight. This reduces the rate of spread of the poison.
- Clean the bite site.
- Tourniquet, incision and suction are not advocated
- Transfer the patient to the nearest medical facility.
- Identify the snake. If dead, carry the snake to the medical service.

b. Management

Poisonous snake-bite is a medical emergency

- Set up an IV line.
- Administer antisnake venom (ASV). It is effective against the circulating poison and not the tissue fixed poison and therefore should be given as early as possible. It is most effective within 4 hours of bite and has no effect after 24 hours of the bite. Polyvalent serum is used if the snake is not identified. Monovalent serum is more potent. Skin sensitivity test must be done before ASV is administered.

  Dose of ASV depends upon the severity of manifestations
  - ❑ 20–50 ml, if only local symptoms are present
  - ❑ 60 ml with systemic manifestations
  - ❑ 100–150 ml with severe systemic manifestations
- Broad-spectrum antibiotics as necessary
- Analgesics
- Steroids, antihistamines, if patient develops reaction to ASV
- Inject tetanus toxoid
- Antianxiolytic as necessary
- Patient should be continuously monitored for vitals and poison manifestations

c. Specific treatments

i. For cobra bite, neostigmine 0.5 mg, intravenously, is given every ½ hour (6 injections) or until symptoms are reversed. Then, 1 mg is given every 2–3 hours till paralysis is completely resolved. Atropine 0.6 mg, intravenously, must precede each neostigmine injection. Watch for relapse of paralysis.

ii. For viper bite, heparin is given. It inhibits clotting and prevents fibrinolytic activity. It is given as 10,000 units followed by 5000 units 6 hourly until all hemorrhagic manifestations disappear. Human fibrinogen 300–400 g, intravenously is given within 24 hours.

Treatment of complications

- Shock – IV fluids (5% albumin preferred), vasopressors
- For prevention of ARF, IV fluids, IV mannitol and furosemide
- Established ARF – Dialysis
- Respiratory failure – Ventilatory support

Scorpion bite (sting)

Indian red scorpion bite is poisonous. Its venom is neurotoxic. Black scorpion bite causes local symptoms.

1. Clinical features

- Black scorpion sting causes local swelling with excruciating local pain, which spreads along the dermatome. Systemic manifestations are none or few (transient fall in BP, bradycardia).
- Red scorpion sting causes autonomic storm. Initially, parasympathetic system and later sympathetic autonomic nervous system are stimulated.

a. Symptoms of parasympathetic stimulation

- Vomiting
- Profuse sweating
- Excessive salivation
- Bradycardia
- Hypotension
- Mydriasis
- Ventricular premature beats
- Priapism

b. Symptoms of sympathetic stimulation

- Anxiety
- Ocular stare
- Chest discomfort
- Oculogyric crisis
- Cold hands and feet
- Coronary spasm
- High BP
- Bradycardia
- Transient, neurologic symptoms
- Pulmonary edema

2. Treatment

a. General measures

For local pain

- Cold or ice application over the bite site is usually adequate
- Injection of a local anesthetic (2% lignocaine without adrenaline)

- Nonsteroidal anti-inflammatory drugs
- For anxiety, anxiolytic drugs such as diazepam
- Antivenom is no more advocated
- Fluids oral or IV to treat dehydration
- Treatment of electrolyte disturbances

b. Specific treatment

Prazosin – It antagonizes the effects of scorpion venom on cardiovascular system. Dose – 125–250 µg for children and 500 µg for adults, repeated every 3 hours till extremities are dry and warm.

Precaution – Prazosin causes postural hypotension, (treated with head low position and IV fluids).

Treatment of complications

- Pulmonary edema
  - ❑ Intravenous furosemide
  - ❑ Sodium isosorbide buccal spray or nitroglycerine powder rubbed on the gums
  - ❑ Intravenous sodium nitroprusside, starting with 3–5 µg/kg/minute; increased if needed or IV nitroglycerine (refer section hypertensive encephalopathy). Systolic BP should be maintained at approximately 80–90 mm Hg
  - ❑ Intravenous aminophylline 5 mg/kg in 5% dextrose given as a slow bolus for bronchospasm
- Treatment of shock, DIC and mental obtundation

Heat stroke

1. **Clinical features**

   Heat stroke is characterized by hyperthermia (core body temperature greater than 40 °C or 105 °F) along with systemic inflammatory response. Severe elevation of body temperature causes denaturation of body proteins, release of inflammatory cytokines, such as tumor necrosis factor-α, interleukin-1β, activation of inflammatory cascade, cellular dysfunction, and ultimately multiorgan failure, which often results in death. Heat stroke can result from prolonged exposure to high temperatures or following exertion by unacclimatized individuals in high ambient temperature and humid atmosphere. (Drugs, such as cocaine, amphetamine, phencyclidine and monoamine oxide inhibitors can cause a syndrome similar to heat stroke. Malignant hyperthermia results from exposure to some anesthetics and antipsychotics.) Other effects of high core temperature are thermal injury to tissues, rhabdomyolysis, ARF, DIC and lactic acidosis. Disseminated intravascular coagulation is more likely with exertion-induced heat stroke.
2. **Diagnosis** of heat stroke is based on history, core body temperature 40 °C (105 °F) or more, and altered consciousness (confusion, delirium, coma).
3. **Differential diagnosis of hyperthermia**
   - Heat stroke
   - Malignant hyperthermia
   - Neuroleptic malignant syndrome
   - Sepsis
   - Cerebral malaria
   - Thyroid storm, pheochromocytoma
   - Anticholinergic poisoning
   - Sympathomimetic drug toxicity
4. **Treatment**
   - Cooling – Cooling measures should be initiated immediately. Many cooling measures are employed, e.g.
     - ❑ Wrapping the patient with bed sheets and wetting the sheets continuously with ice water
     - ❑ Wetting patient's body with tepid water (20–25 °C) and using fans to cool the patient.
     - ❑ Applying icepacks at groins, axillae and chest.
     - ❑ Gastric lavage with ice water or cold peritoneal lavage. Both the measures are controversial and not more effective than external cooling.

     The aim of cooling is to reduce core body temperature to 102° as fast as possible. Patient's temperature should then be monitored continuously as hyperpyrexia can recur.
   - Other measures
     - ❑ For shivering, intramuscular chlorpromazine 10–25 mg or IV diazepam 5–10 mg
     - ❑ For hypertension, sodium nitroprusside (preferred) (refer section hypertensive encephalopathy)
     - ❑ For malignant hyperthermia, IV dantrolene (refer malignant hyperthermia)
     - ❑ For hypotension, IV crystalloids ± vasopressors

     Prognosis – Mortality is high if the core body temperature exceeds 41.1 °C (106 °F).

Frostbite

1. **Definition** – Frostbite is tissue injury, secondary to freezing.
2. **Clinical features** – Clinical features depend upon the duration of exposure and the depth of freezing. The clinical spectrum varies from (minor) superficial damage to gangrene and autoamputation. Symptoms of frostbite can evolve over days to weeks.
3. **Investigations** – Magnetic resonance imaging (MRI), MRA, laser Doppler flowmetry or angiography to assess tissue circulation and tissue viability are done to plan early surgical intervention including amputation. Amputation is delayed as autoamputation can occur. For residual symptoms, such as pain, cold sensitivity and numbness, no definite therapy is available. Sympathectomy may help.
4. **Management**
   a. At the site of "accident"
      - The affected extremity is rewarmed by immersing in warm water (temperature 40–42 °C) for 15–30 minutes. Dry heat and rubbing of the part are not advised as these can aggravate tissue injury.
      - If the patient has to walk to reach the relief facility, rewarming is not done as it increases the danger of tissue injury during walking. In that case the part is gently cleaned, dried and wrapped in sterile compresses.
      - Analgesics including opioids are administered for pain relief. Patient is provided with warm body clothing.

   b. In hospital
      - The affected part is warmed (as described above)
      - Patient is advised to perform gentle movements of the affected part during rewarming
      - Intact vesicles are not broken; others are debrided
      - The affected part is kept elevated
      - Anti-inflammatory medications are administered
      - Analgesics including opioids are used for pain relief
      - Vasodilators (phenoxybenzamine 10–60 mg OD) may help
      - Antibiotics are given if wet gangrene is present
      - Tetanus prophylaxis

Barotrauma and decompression sickness

1. **Introduction**
   Barotrauma involves air-containing spaces of the body. A change in external pressure increases or decreases the volume of gas in these compartments.
   - The amount of dissolved gas (mainly nitrogen and oxygen) in the blood increases with increasing ambient pressure. This results in tissue necrosis and O2 toxicity.
   - During decompression, bubbles of N2 are released, which cause the manifestations of decompression sickness.
   - Air embolism can complicate both compression and decompression stages.
2. **Clinical manifestations** are due to barotrauma to lungs, ears, sinuses, dental cavities, face (due to diving mask) and GI tract. Patients complain of ear pain, vertigo, sinus pain, loss of hearing, dyspnea and abdominal pain. There may be loss of consciousness.
   - Neuro symptoms develop during decompression phase.
   - Bone necrosis is seen with repeated or prolonged exposures.
3. **Treatment**
   - Treatment is symptomatic for mild barotrauma
   - Pneumothorax, GI rupture, neurologic symptoms and abnormal vital signs should be treated.
   - Neuro symptoms and air embolism are treated with recompression in a recompression chamber, followed by slow decompression to normal atmospheric pressure.

Near drowning

Near drowning is defined as suffocation in water, which does not result in death. Because of aspiration and laryngospasm, there is hypoxia which leads to brain damage and multiorgan failure.

1. **Clinical features**
   - Anxiety
   - Vomiting
   - Altered mental state
   - Wheezing (chest symptoms may appear hours later)
2. **Investigations** – Not all investigations given below need be done in all patients. The investigations are
   - Oximetry in all patients

- Arterial blood gas if respiratory symptoms are present
- Serum electrolytes
- Chest X-ray
- X-ray of cervical spine if injury is suspected
- Computed tomography of head in unconscious patients
- Core body temperature (with prolonged submersion)
- Electrocardiogram; cardiac monitoring
- Blood culture, sputum gram stain and culture with pulmonary shadows on chest X-ray

3. **Management** – Management should start immediately. The resuscitative and therapeutic measures depend upon the severity of manifestations.
   - Patients who are asymptomatic or only mildly symptomatic can be observed until symptoms resolve and oxygenation is maintained. At discharge, patient should be advised to return if symptoms (re)appear.
   - In unconscious patients, neck immobilization is necessary. A cervical spine injury should be assumed, especially if drowning follows diving.
   - Exclude stroke and hypoglycemia.
   - Treatment of hypoxia, hypoventilation and in patients with cold water immersion of hypothermia
   - B_2 agonists for wheezing
   - Antibiotics for chest infection
   - Treatment of other manifestations

Anaphylaxis

1. **Clinical manifestations**

   Anaphylaxis is an acute life-threatening emergency. It is an IgE-mediated allergic reaction that occurs in previously sensitized individuals on re-exposure to the sensitizing antigen.

   Symptoms usually develop within minutes of exposure to the antigen. Symptoms are pruritus, urticaria, angioedema, diarrhea, respiratory distress (due to laryngeal edema, laryngeal spasm or bronchospasm), and hypotension.

   Death is mostly due to laryngeal spasm and hypotension.

   Diagnosis is clinical.
2. **Treatment**
   - Immediate – Epinephrine 0.3–0.5 ml of 1:1000 solution intramuscular (in the lateral thigh for maximum absorption); repeated at 10–30 minutes interval if necessary. Alternatively epinephrine can be administered in the following manner.
     - ❑ Epinephrine, 0.3–0.5 ml of 1:1000, can be given sublingually with air way compromise or hypotension.
     - ❑ Epinephrine, 3–5 ml of 1:10,000, can be given intravenously over 3–5 minutes or as an infusion (1 mg of epinephrine in 250 ml D/W = 4 µg/ml) starting with 1 µg/minute and if necessary increased up to 4 µg/minute.
     - ❑ Epinephrine, 3–5 ml of 1:10,000, can be given via endotracheal tube.
     - ❑ Continuous IV infusion may be required for persistent symptoms.
   - Oxygenation – 100% O_2
   - Early endotracheal intubation or tracheostomy if necessary
   - Fluids – Fluids to treat hypotension. Fluid therapy consists of 500–1000 ml bolus of normal saline followed by further fluids to maintain BP and adequate urine output.
   - Vasopressors may be required.
   - Bronchospasm – Inhaled (nebulized) adrenergic agonists (albuterol or metaproterenol) are used for resistant bronchospasm.
   - Both H1 and H2 histamine blockers are given every 6 hours until the symptoms resolve.
   - Corticosteroids have no role in the immediate treatment but may prevent delayed reaction. A single dose of 125 mg of methylprednisolone is adequate.

Septicemia

Septicemia is diagnosed, when in the presence of infection, systemic inflammatory response, and/or organ dysfunction is present. There is a critical reduction in tissue perfusion. Gram negative bacteria, staphylococci and meningococci are the common infecting organisms.

1. **Clinical manifestations**
   - Fever with shaking chills
   - Low BP; cold and pale extremities
   - Oliguria (less than 0.5 ml/kg/hour)
   - Confusion
   - Symptoms and signs of (multi) organ failure
2. **Investigations** – Before initiating antibiotic treatment, specimens of suspected body fluids should be sent for Gram staining and culture.

Two blood culture samples (collected separately from two different lines) should be obtained. The following investigations are done.

- Complete blood count
- Urine (routine)
- Arterial blood gases
- Chest X-ray
- Serum lactate
- Liver function tests
- C-reactive protein (CRP)
- Procalcitonin
- Serum cortisol (less than 9 mcg/dl response to corticotropin test) suggests inadequate adrenal response to stress
- Electrocardiogram
- 2D Echo

3. **Diagnosis** – Diagnosis is clinical. Levels of CRP and procalcitonin are elevated but are nonspecific.
4. **Treatment**
   - Patient is treated in ICU.
   - Appropriate and early antibiotic treatment reduces sepsis-related mortality.
   - Antibiotic therapy can be specific, if infective agent or source of infection is identified or until then, empirical. (before initiating antibiotic treatment, body fluid specimens and blood culture specimens from patients with suspected sepsis should be obtained.)
   - Empiric antibiotic treatment consists of a combination of β-lactam and an aminoglycoside. Vancomycin is sometimes added if resistant staphylococcal or enterococcal infection is suspected (e.g. nosocomial infection, patient with central venous catheter).
   - Community-acquired infection (sepsis) can be treated with a third-generation cephalosporin and vancomycin.
   - In asplenic patients, third-generation cephalosporin in high doses is combined with vancomycin.
   - In neutropenic patients, a combination of antipseudomonal antibiotic and aminoglycoside is used. In addition, other measures to treat shock are instituted.
   - Additional measures include aggressive fluid replacement, supportive care, control of blood glucose, corticosteroids, activated protein C, surgical drainage and excision of necrotic tissue, strict control of blood glucose with insulin, and early treatment of renal failure.

Cardiopulmonary resuscitation

All over the world, sudden cardiac arrest (SCA) is the leading cause of death. It is the most serious emergency that warrants immediate resuscitative measures. Even slight delay can adversely reflect not only on the revival of heart beat but also on the prevention of brain death. Cardiac arrest results due to either cardiac asystole or VF, the latter carries a better prognosis than the former. The survival after SCA depends upon the following factors.

- Early recognition and immediate management of cardiac emergencies to prevent cardiac arrest;
- Immediate cardiopulmonary resuscitation (CPR) to minimize injury to vital organs;
- Early defibrillation to restore heart beat;
- Early life support by IV drip and vasopressors to restore functions of vital organs, including return of brain functions. One may summarize that one should follow in a precise manner, basic life support (BLS) and advanced life support (ALS), one after another, to achieve the best outcome.

1. **Basic life support**

   This can be carried out by any person (whether medical, paramedical or lay person) present at the spot of occurrence of SCA. The aim of BLS is to maintain circulation (with external cardiac massage) and ventilation (with mouth-to-mouth breathing) till patient is shifted to a hospital or till ambulatory help (cardiac ambulance) arrives.

- When a person is found in a collapsed state, assess his responsiveness by calling or striking him. Feel for carotid pulsations.
- If there is no response, call for assistance right away.
- Put the person on floor or a hard surface in supine position.
- Check the airway. If a foreign body is suspected, roll the patient and give four to five forceful blows in the interscapular area and roll back the patient to supine position. Give abdominal thrusts just below the xiphisternum in an upward direction. Check presence of foreign body in the pharynx with index finger by sweeping deeply across the posterior pharynx.
- Open the victim's airway using "head tilt–chin lift." This clears the airway of a comatose patient by shifting the tongue and epiglottis away from the posterior pharyngeal wall (Figs. 15.1A and B).

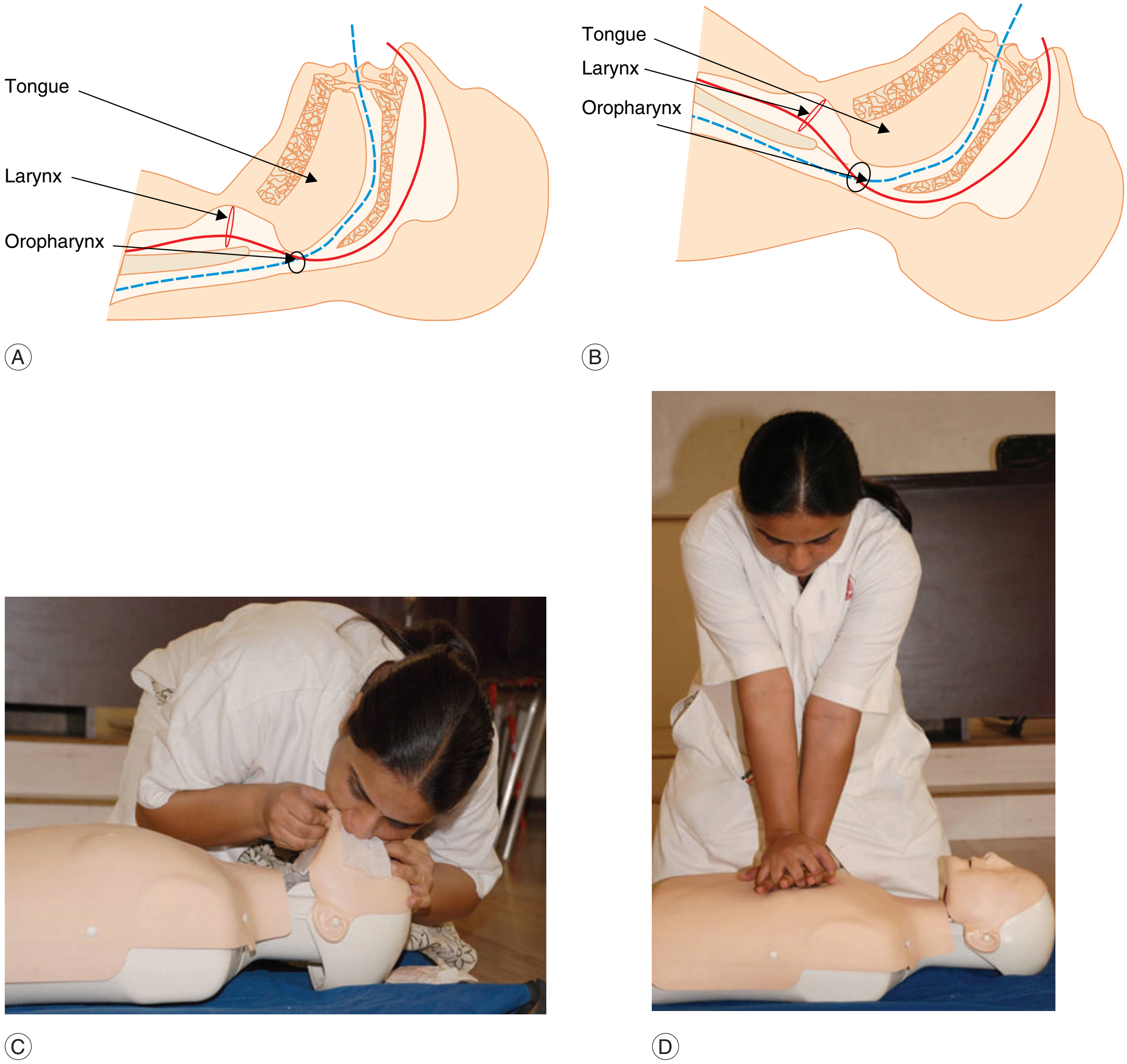

Figure 15.1 (A) In supine position, the tongue falls back and obstructs the airway at the oropharynx. (B) In supine position, with head tilted backwards, the tongue is lifted up opening the airway. (C) Mouth-to-mouth respiration. (D) External cardiac massage.

- Check whether the patient is having an effective breathing by observing movements of mouth, nose, cheeks, chest and abdomen. If the patient is gasping and has weak respiration, he needs mouth-to-mouth breathing.
- If carotid pulse is absent or weak and respirations are weak, start external cardiac massage and mouth-to-mouth breathing cycles.
- Cardiac massage is started by placing the heel of one hand on the middle of the chest. The heel of the other hand is kept over the first hand with fingers of the two hands interlocked. The person should lean vertically over the patient's chest and push hard and fast at the rate of 100 compressions per minute (Fig. 15.1D). Compression and relaxation times should be equal. With an open airway, these compressions are adequate for gas exchange. After continuous 30 compressions, the person himself or other person (helper) delivers two rescue breaths (mouth-to-mouth breathing; Fig. 15.1C) to keep the airways open. Avoid forceful

mouth-to-mouth breathing. Prior to rescue breath, the person should inspire normally and should blow with an airtight mouth-to-mouth seal. Immediately, restart the cycles of 30 compressions and two rescue breaths for 2 minutes and then assess carotid artery pulsations and breath sounds. Continue the cycles till active life system team arrives.

- Defibrillation
  - ❑ Ventricular fibrillation is the commonest cause of SCA; while CPR will help in maintaining vital organ perfusion, it will not change VF to sinus rhythm and for that defibrillation is life saving. Nowadays, we have automated external defibrillators that can recognize rhythm abnormality and treat the same. Treat VF/VT with a single shock. If stable sinus rhythm is not achieved, repeat 30 compressions followed by the rescue breaths.
  - ❑ Postdefibrillation CPR – Give CPR (30 compressions with two rescue breaths) immediately after defibrillation. After 2 minutes of CPR, check rhythm. If not successful, give another direct current (DC) shock.

2. **Advanced life support** – This CPR is carried out by a medical person in hospital in an ICU or an emergency care area where cardiac monitor, DC defibrillator and ventilators are available.
   - ❑ For keeping airway open, endotracheal tube is introduced without interrupting CPR for more than 30 seconds. Oxygen is delivered through endotracheal tube. Till a ventilator is available, Ambu bag can be used.
   - ❑ Peripheral lines should be established for administration of vasopressors (adrenaline and noradrenaline along with IV dextrose normal saline). Any arrhythmias detected should be corrected immediately. One must ensure adequate ventilation with 100% oxygen. Acidosis, hyperkalemia, hypokalemia, hypocalcemia and other metabolic disorders are identified and corrected immediately. Electrocardiogram, chest X-ray and 2D Echo should be done to diagnose acute myocardial infarction, pericardial tamponade, pneumothorax, pulmonary embolism (PE) and managed accordingly.

- Cardiac asystole and pulseless electrical activity do not respond to DC shock and carry poor prognosis if the patient has not responded to CPR and adrenaline injection.
- Drugs commonly used in advanced cardiac life support
  - ❑ Intravenous adrenaline, 1 mg, given if VT/VF persists after two DC shocks. In cardiac asystole, same dose is used, and if there is no response, give 1 mg intravenously every 3–5 minutes till the return of cardiac systole. One may use noradrenaline additionally.
  - ❑ As an antiarrhythmic, amiodarone 360 mg IV bolus, followed by additional 150 mg IV if required
  - ❑ Atropine – Used mainly in cardiac asystole (usually given as a single dose of 3 mg along with CPR)

Prognosis

Advanced life support can achieve restoration of circulation in 45% of cases. Approximately 5% of prehospital SCA patients and about 15% of in-hospital SCA get discharged with full recovery including neurological recovery. Approximately 50% die in spite of all efforts. The remaining may survive but may have some neurological deficit or some organ dysfunction.

Acute left ventricular failure (pulmonary edema)

Pulmonary edema is due to acute left ventricular failure (LVF) with pulmonary venous hypertension. There is flooding of alveoli with fluid.

1. **Symptoms** – Evolution of symptoms may be rapid. These are
   - Extreme dyspnea
   - Sense of suffocation
   - Restlessness
   - Anxiety
   - Cough with pink frothy expectoration (±)
2. **Signs**
   - Tachypnea with use of accessory muscles of respiration, cyanosis
   - Tachycardia with low-volume pulse
   - Marked diaphoresis
   - Variable BP (markedly elevated BP indicates significant cardiac reserve. Hypotension is a poor prognostic sign)
   - Decreased peripheral perfusion
   - Summation gallop
   - Signs of right ventricular failure may be present
   - Bilateral bubbling crepitations
   - Wheezing may be present (cardiac asthma)

3. **Investigations**
   X-ray
   May show cardiomegaly
   - Perivascular hilar prominence
   - Increased interstitial markings
   - Kerley's B lines (see Fig. 3.27)
   - Pleural effusion
   - Diffuse alveolar shadowing
4. **Treatment**
   - Propped up position
   - 100% O_2 with nonrebreather mask or if necessary, with mechanical ventilation
   - Intravenous morphine sulfate, 2–5 mg, slowly; repeated once or twice
   - Intravenous furosemide, 20–80 mg, slowly (can be increased up to a maximum of 200 mg as per response)
   - Nitroglycerine 0.4 mg sublingually every 5 minutes followed by an IV drip at 10–20 µg/minute, titrated upwards every 5 minutes (as needed) to a maximum of 300 µg/minute or till BP of 90 mm Hg is reached
   - Sodium nitroprusside if pulmonary edema is due to hypertension or acute aortic regurgitation.
   - Pulmonary and systemic catheterization for monitoring
   - Inotropic support if hypotension or shock is present
   - Recombinant brain natriuretic peptide (relieves pulmonary edema)
   - Hemodialysis or ultrafiltration with renal failure
   - Additional specific treatment depends upon the cause, (arrhythmia, severe hypertension)
   - Poststabilization and long-term treatment of heart failure is necessary

Shock

Shock is decreased blood flow and oxygen delivery to the tissues. It manifests with poor peripheral pulses, sweating, oliguria and altered mentation.

Therapy involves restoration of tissue perfusion with fluids and inotropes.

1. **Fluids** – This is the first therapeutic measure. Normal saline or ringer lactate is administered. Colloid solutions are not essential. With anemia or active bleeding, blood transfusion is necessary. Indication for blood transfusion is hematocrit less than 20–25% in the young and less than 30% in elderly patients.
   - Colloids (albumin, hydroxyethyl starch, dextrans) – These are useful with major hemorrhage. However, studies have shown no major advantage of colloids over crystalloids. Albumin has a negative inotropic effect. Hydroxyethyl starch and dextran affect coagulation if more than 1.5 l is administered. Blood substitutes (fluorocarbons) have shown no survival advantage.
     - ❑ The amount of fluid administered depends upon BP response, urine output, central venous pressure, and cardiac output.
2. **Vasopressors and inotropes**
   - Dopamine – The hemodynamic effects of dopamine are dose dependent. (1) At less than 5 µg/kg/minute, dopamine increases renal and splanchnic blood flow due to vasodilation, (2) at 5–10 µg/kg/minute, dopamine increases cardiac output (by the activation of β-cardiac receptors) and (3) at greater than 10 µg/kg/minute, dopamine increases BP (via activation of peripheral α-receptors).
   - Dobutamine – Dobutamine increases cardiac output (inotropic effect), decreases peripheral resistance, and the after load. It has a weak chronotropic effect and increases heart rate modestly.
   - Epinephrine – It is the drug of choice in anaphylactic shock. Its effects are dose dependent.
   - Norepinephrine – It has inotropic and an chronotropic effects and increases cardiac output.
3. **Oxygen**
   - Binasal catheter – One liter O_2/minute is equal to 24% fractional inspired oxygen (FIO_2); with each additional 1-l flow rate, FIO_2 increases by 4%. Maximum rate should be less than 5 l/minute.
     - ❑ Advantages – Allows patient to eat, drink and speak.
     - ❑ Disadvantages – Above estimates are approximations. Actual FIO_2 cannot be judged correctly.
   - Venturi masks
     - ❑ Advantage – Exact amount of FIO_2 can be determined. FIO_2 of 24, 28, 31, 35 and

50% can be delivered. It is a useful way to treat patients of chronic obstructive pulmonary disease with hypercapnia.

- Nonrebreathing masks – These can achieve an FIO_2 of 80–90%.
- Continuous positive airway pressure (CPAP) mask – This is indicated if PaO_2 remains less than 60% with the above measures. Prerequisites for CPAP are conscious, cooperative, and hemodynamically stable patients who are unlikely to aspirate.
  - ❑ The pressure applied varies from 3–5 cm H_2O to 10–15 cm H_2O depending upon FIO_2 attained.
  - ❑ Disadvantage – All patients do not tolerate CPAP.
- Bilevel positive airway pressure – In this, both inspiratory and expiratory pressures can be applied to the mask.
  - ❑ Advantage – It decreases the work of breathing, improves gas exchange and prevents alveolar collapse.
- Endotracheal intubation is indicated if above measures are not successful.

Treatment of individual types of shocks

Hypovolemic shock – It is treated with fluids. Fluid replacement should be fast (initial 500–1000-ml bolus). Infusion pump is useful. Unless there is blood loss, crystalloids are used to replenish lost fluids.

Cardiogenic shock – The therapy includes

- Maintaining PaO_2 greater than 60% with O_2 administration
- Maintaining hematocrit of 30% or more
- Mechanical ventilation to improve oxygenation and reduce the work of breathing
- Fluid replacement to maintain preload but at the same time avoiding fluid overload (pulmonary edema)
- Vasopressors, usually starting with dopamine
- Mechanical circulatory support by intra-aortic balloon counter pulsations. It decreases after load and improves coronary blood flow. Indication for its use is failure of response to medical therapy

i. Obstructive shock – It is due to massive PE. Apart from fluid replacement and vasopressors, definitive treatment consists of thrombolysis or surgical embolectomy.

ii. Septic shock – It is a distributive shock. Treatment consists of

- Fluid replacement to maintain central venous pressure of 8–12 cm H_2O
- Human activated protein C. It is antithrombotic, antifibrinolytic and anti-inflammatory; it is indicated in sepsis with two or more acute organ failure or Acute Physiologic Assessment and Chronic Health Evaluation (APACHE) score of 25 or more; Score range is 0–71.
- Hydrocortisone 50 mg IV, every 6 hours and fludrocortisone 50 mg IV in patients with adrenal insufficiency

iii. Anaphylactic shock (refer anaphylactic shock)

Hypertensive encephalopathy

Hypertensive encephalopathy is due to failure of autoregulation of cerebral blood flow. Dilatation of cerebral vessels results in transmission of increased pressure to the capillaries with the development of cerebral edema and papilledema.

1. **Clinical features**
   - High BP with diastolic BP greater than 120 mm Hg
   - Changing neurologic deficits – A characteristic feature. Deficits may be cortical blindness, hemiplegia, convulsions, confusion etc.
   - Additionally cardiovascular and renal manifestations may be present
2. **Investigations**
   - Urine(R) (for RBCs, RBC casts and proteinuria)
   - BUN, creatinine (may be raised)
   - Electrocardiogram (may show left ventricular hypertrophy, ischemia)
   - Computed tomography brain (to detect hemorrhage, edema)
3. **Treatment**
   - Patient is treated in an ICU.
   - Blood pressure is reduced progressively with a short-acting, titrable IV antihypertensive agent. Abrupt lowering of BP should be avoided. Aim is to reduce mean arterial pressure by 20–25% in an hour or so. Simultaneously patient's symptoms are monitored.
   - Drugs for lowering BP
     - ❑ Sodium nitroprusside – Starting with a dose of 0.25–1.0 μg/kg/minute IV infusion, titrated with increments of

0.5 µg/kg; maximum dose 8–10 µg/kg/minute; maximum dose should not to be given for more than 10 minutes (to reduce the risk of cyanide poisoning)
    - ❑ Intravenous nicardipine 5–15 mg/hour
    - ❑ Nitroglycerine 5–100 µg/minute, as IV infusion
    - ❑ Labetalol 20 mg, IV bolus over 2 minutes followed by 40 mg after 10 minutes, and then up to three doses of 80 mg; alternatively labetalol can be given at the rate of 0.5–2 mg/minute as an IV infusion
    - ❑ Esmolol 250–500 µg/kg/minute × 1 minute, followed by 50–100 µg/kg/minute for 4 minutes; cycles may be repeated
    - ❑ Phentolamine 5–15 mg IV
- Precautions
    - ❑ Oral nifedipine although effective is not advocated for fear of cardiovascular and cerebrovascular events developing due to precipitous fall in BP.
    - ❑ Administration of nitroprusside greater than 2–3 µg/kg/minute can cause cyanide poisoning (with CNS and cardiac manifestations and acidosis). Serum thiocyanate levels should be estimated after 48–72 hours with high doses of nitroprusside and after 5–7 days with lower doses. The IV bag and tubing should be wrapped in an opaque covering as ultraviolet rays breakdown nitroprusside. Nitroglycerine is preferred over sodium nitroprusside in patients with severe CAD.
    - ❑ Nicardipine can decrease glomerular filtration rate in patients with renal insufficiency.
    - ❑ Labetalol is not used in patients with asthma.

Cardiac tamponade

Cardiac tamponade is due to increased pressure in the pericardial cavity because of pericardial fluid.

1. **Clinical manifestations**
    - Low-volume pulse, hypotension
    - Tachycardia, pulsus paradoxus
    - Dyspnea
    - Elevated jugular venous pressure
    - Poor peripheral circulation
    - Muffled or distant heart sounds
2. **Investigations**
    - Electrocardiogram
        - Low-voltage complexes (see Fig. 10.6)
        - Tachycardia
        - Electrical alternans
    - 2D echo to confirm the diagnosis
3. **Treatment**
    - Immediate pericardiocentesis, preferably under echocardiographic guidance. Removal of even a small amount of fluid provides relief to the patient.
    - If pericardiocentesis is not possible, then the patient is treated with parenteral inotropic support and IV saline to maintain adequate ventricular filling.
    - Diuretics, nitrates and agents that reduce preload are absolutely contraindicated.

Complete heart block

Complete heart block (CHB) is complete AV dissociation with idioventricular rhythm. Complete heart block can be congenital or acquired. (see Figs. 10.44 and 10.45)

1. **Clinical features**
    - Can manifest with syncope and heart failure
    - Signs – Cannon "a" waves, fluctuating BP, and changing intensity of 1st heart sound
2. **Treatment**
    - For symptomatic patients or for patients with heart rate less than 30/minute, pacemaker insertion is necessary
    - Isoprenaline 1 mg in 500 ml of 5% dextrose can be given as a slow drip (1–4 µg/minute) to achieve the desired heart rate.
    - If CHB is due to a drug, the medication should be stopped.
    - If CHB is due to inferior wall myocardial infarction, IV atropine helps. It can resolve spontaneously also. Complete heart block secondary to anterior wall infarction usually needs introduction of a pacemaker. Similarly patients with congenital CHB need introduction of pacemaker before the middle age is reached.

Stokes–Adams syndrome

1. **Clinical presentation**
   Stokes–Adams syndrome is poor or absent ventricular output leading to cerebral ischemia with syncope or unconsciousness.

2. **Treatment**
   - Immediately, a sharp blow is given over the precordium. This may resuscitate the patient. If not, CPR is started.
   - If ECG shows VF, cardioversion defibrillation with DC defibrillator is carried out; patient may need permanent pacemaker.
   - Drugs – Till the pacemaker is inserted, in case of ventricular asystole, following drugs can be given:
     - ❑ Isoprenaline, 0.1–0.4 mg IV direct injection or 1 mg in 200 ml of 5% dextrose given as a drip
     - ❑ Adrenaline, 0.2–0.5 ml in 1:1000 solution, IV
     - ❑ Sodium bicarbonate, 100 ml of 7.5% solution for acidosis
     - ❑ Hydrocortisone 100 mg IV to relieve edema around the AV node

Atrial fibrillation

1. **Definition** – Atrial fibrillation (AF) is rapid irregular atrial rhythm (see Fig. 10.48)
2. **Clinical features**
   - Palpitations
   - Vague chest discomfort
   - Embolic manifestations (e.g. stroke)
3. **Investigations**
   - Electrocardiogram to confirm the diagnosis
   - 2D Echo for the diagnosis of underlying heart disease and atrial thrombi
   - Thyroid function tests
4. **Treatment** – Principles of treatment are –
   - Treat the cause
   - Control ventricular rate
   - Control rhythm
   - Prevent thromboembolism

   Control of ventricular rate
   - Beta blockers (metoprolol, esmolol; IV for acute AF)
   - Nondihydropyridine calcium channel blockers (verapamil, diltiazem; IV for acute AF)
   - Digoxin for heart failure (oral or IV)
   - Amiodarone (alone or in combination), if above measures fail
   - Radiofrequency ablation of AV node with pacemaker insertion, if above measures fail or there is intolerance to drugs

Drug doses

- Metoprolol
  - ❑ Intravenous 2.5 – 5 mg every 5 minutes up to a maximum of 15 mg
    - ❑ Oral 50–100 mg BD
- Esmolol
  - ❑ Intravenous 50–200 μg/kg/minute
- Propranolol
  - ❑ Intravenous 1–3 mg over 1 minute; repeated after 5 minutes if necessary
  - ❑ Oral – 10–30 mg tds or QDS
- Verapamil
  - ❑ Intravenous 5–15 mg over 10 minutes
  - ❑ Oral – 40–120 mg tds
- Diltiazem
  - ❑ Intravenous 5–15 mg/hour up to 24 hours
  - ❑ Oral – 120–360 mg OD (slow release diltiazem)
- Amiodarone
  - ❑ Intravenous 150–450 mg over 1–6 hours followed by maintenance dose of 0.5–2.0 mg/minute
  - ❑ Oral 600–1200 mg/day × 7–10 days. Then, 400 mg/day × 3 weeks and maintenance dose of less than or equal to 200 mg/day
  - ❑ Precaution – β-blockers should not be given to patients with Wolf Parkinson White syndrome (clue QRS is wide)

Rhythm control

1. **Indications** – Heart failure or hemodynamic disturbances secondary to recent onset AF
2. **Treatment**
   - Synchronized cardioversion
   - Antiarrhythmic drugs for conversion to sinus rhythm
     - ❑ **Class** 1a (procainamide, quinidine, disopyramide)
     - ❑ **Class** 1c (flecainide, propafenone) or
     - ❑ **Class** III (amiodarone, sotalol). These should not be used until heart rate has been controlled by a β-blocker or nondihydropyridine calcium channel blocker. Can be used for long-term maintenance therapy also.
3. **Precautions**
   - Before conversion, heart rate should be less than 120 beats/minute.
   - If AF is of greater than 48-hour duration, adequate anticoagulation with warfarin is

essential for 3 weeks before cardioversion and it should be continued postconversion for 4 weeks or on a long-term basis. (If there is no atrial clot, cardioversion can be done immediately with heparin anticoagulation.)

Prevention of thromboembolism

Anticoagulation with warfarin or acetrom. International normalized ratio should be maintained between 2 and 3.

Atrial flutter

1. **Definition**

   Atrial flutter is rapid regular atrial rhythm (see Fig. 10.47).

   Diagnosis is by ECG.
2. **Treatment**
   - Principles of treatment are same as for AF.
   - Pharmacologic control of atrial flutter is more difficult than that of AF (drugs are the same).
   - Electrical cardioversion is preferred.
   - Maintenance therapy.
     - ❑ Class 1a or lc antiarrhythmics can be used to slow the atrial flutter (caution – these can increase the heart rate by facilitating 1:1 AV conduction).
     - ❑ Antitachycardia pacing.
     - ❑ Ablation to interrupt atrial re-entrant circuit.
     - ❑ Long-term anticoagulation for patients with chronic atrial flutter or recurrent atrial flutter.

Ventricular tachycardia

1. **Definition** – Three or more consecutive ventricular beats at the rate of 120 or more beats/minute constitute ventricular tachycardia (VT; see Fig. 10.52)
2. **Clinical features**
   - Manifestations depend upon the duration of VT and vary from asymptomatic to hemodynamic instability and death.
   - Ventricular tachycardia is usually a manifestation of an underlying heart disease. Aggravating factors are often present.
3. **Treatment**
   - Nonsustained VT does not need immediate treatment. If frequent, antiarrhythmic drugs are indicated.
   - Acute hypotensive VT is treated with synchronized (DC) cardioversion of greater than or equal to 100 joules.
   - Stable VT.
     - ❑ Lidocaine 100 mg intravenously over 2 minutes followed by continuous infusion of 4 mg/minute (1/2 the dose for patients above 65 years of age) is administered. A bolus dose of 50 mg can be repeated 5 minutes after the first dose. Lidocaine acts fast but is not always effective.
     - ❑ If lidocaine is not effective, IV procainamide 10–15 mg/kg bolus is given at the rate of 25–50 mg/minute, followed by infusion of 1–4 mg/minute. Disadvantage is slow onset of action.
     - ❑ Failure of above measures is an indication for cardioversion.
   - Long-term treatment for prevention of VT
     - ❑ Implantable cardioverter-defibrillator
     - ❑ Antiarrhythmic drugs (refer table on antiarrhythmic drugs)
     - ❑ Transcatheter radiofrequency or surgical ablation of the arrhythmic focus

Ventricular fibrillation, flutter

1. **Definition** – Ventricular fibrillation is a disorganized, chaotic activity of heart (see Fig. 10.53). It is seen on the ECG as deformed and irregular QRS complexes. Unless cardioverted VF is fatal.

   Ventricular flutter is rapid, regular, ectopic ventricular cardiac rhythm with widened, bizarre sine-like complexes.
2. **Treatment** – CPR (described separately) is most successful if carried out within 3 minutes of the onset of VF. Even so mortality is high.

Torsades de pointes

1. **Definition** – Torsades de pointes is a polymorphic ventricular arrhythmia, characterized by QRS complexes of changing amplitude and a characteristic twisting around the isoelectric line of ECG. It occurs in patients with prolonged QT syndrome. The arrhythmia can evolve into VF.
2. **Clinical manifestations**
   - Syncope
   - Palpitations
3. **Diagnosis** is based on ECG findings.

4. **Treatment**
   - Hemodynamically unstable patient is treated with unsynchronized cardioversion (100 joules). Recurrence is common.
   - Intravenous $MgSO_4$ 2 g given over 1–2 minutes is often effective. A second bolus may be required. If renal function is normal, infusion at the rate of 3–20 mg/minute can be given after the bolus dose.
   - Intravenous isoproterenol 1–2 mg/minute or temporary pacemaker to increase the heart rate to 90–120/minute is given to shorten the QT interval.
   - Lidocaine (shortens QT interval) may be effective in drug-induced arrhythmia.
   - All drugs that are likely to be the cause should be discontinued. For congenital prolonged QT syndrome, the treatment of choice is β-blockers or permanent pacing or both. Family members should be evaluated.

Aortic dissection

1. **Definition** – Dissection of aorta is separation of intima from media. There is tear in the intima that allows blood to enter between the intima and the media.
2. **Etiology** – Aortic dissection is most commonly secondary to atherosclerosis and hypertension. Other causes include acquired connective tissue disorders (e.g. syphilis, Takayasu's arteritis), congenital, or hereditary connective tissue disorders (e.g. coarctation of aorta, Marfan syndrome, bicuspid aortic valve), iatrogenic (e.g. aortic catheterization, aortic valve surgery) and trauma.
3. **Clinical features**

   Typical presentation – Abrupt onset of severe chest pain (mimicking myocardial infarction) or back pain.

   Other presentations are
   - Cardiac tamponade
   - Aortic regurgitation
   - Myocardial infarction
   - Syncope, stroke
   - Paraplegia
   - Intestinal infarction
   - Limb ischemia

   Signs (vary with the vessels affected)
   - Major arterial pulse deficits
   - Blood pressure difference in the limbs
   - Aortic incompetence ± acute LVF
   - Pleural effusion
   - Limb ischemia, neuropathy
   - Renal failure
4. **Diagnosis**
   - (Usually) ECG and cardiac enzymes are normal.
   - Chest X-ray may be suggestive of dissection
   - Computed tomography
   - Magnetic resonance imaging
   - Multiplanar transesophageal echocardiography (TEE)
     - ❑ (CT_1, MRI or multiplanar TEE is done after the patient is stabilized. All are diagnostic)
   - Contrast angiography
   - 2D Echo (for aortic regurgitation)
5. **Prognosis** – Without treatment mortality is high.
6. **Management**
   - Treat in ICU
   - Intra-arterial BP monitoring
   - Monitor urine output with an indwelling catheter
   - Grouping and cross matching of blood
   - Intubate (if patient hemodynamically unstable)
   - Decrease BP. Aim systolic BP of 110 mm Hg or the lowest compatible level. Intravenous propranolol is commonly used (refer hypertensive encephalopathy for dose and alternatives).
   - Surgery, especially with proximal aortic dissection, intestinal ischemia, uncontrolled hypertension, progressive dissection
   - On recovery, long-term antihypertensive therapy

Status asthmaticus (severe acute asthma)

Status asthmaticus is characterized by severe and persistent airway obstruction despite treatment of acute asthma.

1. **Clinical manifestations**
   - Severe dyspnea with prominent use of accessory muscles of respiration
   - Patient sitting upright or leaning forward with arm support
   - Cyanosis
   - Dry cough
   - Tachycardia, pulsus paradoxus
   - Sweating

2. **Treatment**
   a. At home
      i. High concentration O_2 using a mask
      ii. Bronchodilators
   - Nebulized salbutamol (5 mg) or terbutaline (10 mg) every 20 minutes × 3 doses. Alternatively salbutamol or terbutaline 4–8 puffs by metered-dose inhalers every 20 minutes × 3 doses or salbutamol 250 µg or terbutaline 250–500 µg by slow IV infusion
   - Aminophylline 5 mg/kg IV given over 20 minutes (provided patient has not been taking or has not received aminophylline)
   - Hydrocortisone 200 mg IV or prednisolone 40 mg oral

   b. **In hospital treatment**
      i. O_2 – 35–60%
      ii. Salbutamol (5 mg) or terbutaline (10 mg) by nebulization, repeated within minutes if there is no response. For patients with excessive cough or who are too exhausted or moribund, terbutaline 0.25–0.5 mg subcutaneous or IV (0.1–10 µg/kg/minute) or epinephrine 0.2–0.5 mg of 1:1000 solution subcutaneous every 10 minutes in young adults
      iii. If patient does not respond to above measures, IV aminophylline 5 mg/kg/hour loading dose as an infusion, provided the patient has not been taking or has not received aminophylline
      iv. Hydrocortisone 200–500 mg IV, every 4–6 hours in severely ill patients or oral prednisolone 40–60 mg stat, followed by 20 mg, every 6 hours
      v. Endotracheal intubation and ventilatory support if above measures fail
      vi. Assisted ventilation. Noninvasive ventilation in cooperative and alert patients with impending respiratory failure

   Indications for assisted ventilation
   - Cardiac or respiratory arrest
   - Severe hypoxia
   - Exhaustion
   - Mental obtundation
   - Antibiotics with suspected infection

Hemoptysis

1. **Introduction**
   Hemoptysis is coughing of blood. It needs to be differentiated from hematemesis (see Chapter 4) and pseudohemoptysis (bleeding from upper respiratory tract and oral cavity).
2. **Investigations** to determine the cause of hemoptysis
   - Complete blood count including platelet count
   - Prothrombin time or INR (clotting abnormalities)
   - Liver function tests if PT or INR is abnormal
   - Serum creatinine
   - Sputum for bacteria, mycobacteria and cytology
   - Urine (RBC, RBC casts, proteins)
   - Arterial blood gases
   - Chest X-ray, CT scan
   - Others as indicated
3. **Management** – Management involves general measures, measures to stop bleeding and determining the cause.
   - Small or scanty hemoptysis needs no specific treatment except reassurance as small hemoptysis stops spontaneously. However, its cause needs to be investigated.
   - Profuse hemoptysis (greater than 500 ml in 24 hours or associated with respiratory compromise)

     The main objectives of treatment are to prevent aspiration of blood in the uninvolved lung and prevent exsanguination
   - Mild anxiolytic (e.g. alprazolam) to allay patient's anxiety avoid heavy sedation
   - Bed rest in semi-reclined lateral decubitus position (lie on the affected side)
   - Ensure adequate oxygenation
   - Monitor pulse, respiration, BP; maintain adequate BP
   - Protect air-way by proper suctioning; intubate if necessary with a double lumen endotracheal tube, (intubates the two main bronchi separately). This prevents flooding with blood of the healthy lung
   - Complete blood count, grouping cross-matching, coagulation tests and ABG.

     Measures to stop bleeding include–
   - Bronchoscopy (rigid bronchoscope is preferred as it permits better suctioning and

therapy such as ice cold lavage, and local injection of epinephrine).
- Balloon tipped Fogarty catheter is introduced through a bronchoscope and inflated proximal to the bleeding site. It can be kept for hours to days.
- Bronchial artery embolization is the preferred treatment.
- Surgery – Ligation of the bronchial artery or resection of the affected lung is necessary if above measures fail.
- Antibiotics if bleeding is due to bronchiectasis (infection is the usual cause).

  Specific treatment depends upon the cause of hemoptysis
- Fresh frozen plasma for prolonged PT or elevated INR
- Platelet transfusion for thrombocytopenia
- Treatment of tuberculosis, aspergillosis

Tension pneumothorax

Pneumothorax is characterized by progressive increase in intrapleural pressure, which remains positive throughout the respiratory cycle. There is collapse of the lung, mediastinal shift to the opposite side and impaired venous return to the heart. The cause of pneumothorax can be an underlying lung disease, trauma, a medical procedure or it can be spontaneous (see Fig. 11.19).

1. **Diagnosis** – There is sudden onset of rapidly progressive breathlessness with
   - Severe dyspnea, cyanosis, tachycardia, hypotension and diaphoresis
   - Bulging intercostal spaces on the affected side with absence of respiratory movements of the hemithorax
   - Marked shift of the mediastinum to the opposite side
   - Hyperresonant percussion note
   - Absence of breath sounds
     - ❑ Chest X-ray confirms the diagnosis.
2. **Management**
   - A large bore needle (17–18-gauge BD needle passed through a sterilized cork or flat rubber piece, which acts as a hilt) is introduced in the pleural cavity in the 2nd intercostal space in the midclavicular line after local infiltration with 2% lignocaine (see Fig. 4.48).
     - ❑ As the needle enters the pleural space, air escapes. This reduces intrapleural pressure with relief of dyspnea.
     - ❑ The needle is connected to an underwater seal which is connected to a suction pump. A negative pressure of 20–30 cm of water is applied for effective suction.
   - O_2 is administered at 8–10 l/minute
   - If shock or hypotension persists, IV fluids along with vasopressors are administered.
   - If there is hydropneumothorax, a separate drain is introduced at a lower level to drain the fluid.
   - Treatment of underlying pathology is instituted.

Pulmonary embolism

Pulmonary embolism can be due to blood clots, fat, air, foreign bodies or tumor emboli.

1. **Clinical features**
   - Tachycardia
   - Tachypnea
   - Clear chest or a few crepitations and rhonchi
   - Loud P_2 right ventricular S_4
     - ❑ Unexplained chest pain and dyspnea in a patient with predisposing factors must always raise the possibility of PE.
2. **Investigations**
   - Electrocardiogram – Typical S1 Q3 T3 pattern, nonspecific ST–T changes
   - Chest X-ray – May be normal or shows peripheral wedge-shaped pleural-based opacity, peripheral oligemia with increased central vascular markings, elevated hemidiaphragm; collapse, consolidation
   - D-dimer; low D-dimer virtually excludes PE
     - ❑ V/Q scan for ventilation–perfusion mismatch
     - ❑ Lower limb venous Doppler for deep venous thrombosis (DVT)
     - ❑ Pulmonary angiography and spiral CT are confirmatory
3. **Treatment**
   - Establish an IV line
   - Symptomatic treatment including opiates for pain relief

- Local thrombolytic or fibrinolytic therapy – (1) 50,000–60,000 units of streptokinase injected in pulmonary artery, followed by further 1,00,000 units given over 48–72 hours; clot lysis occurs over 3–5 days, or systemic thrombolysis with a loading dose of streptokinase 2.5 lac given over 30 minutes, followed by 1 lac units/hour × 24 hours, or (2) Loading dose of urokinase 4400 units/kg given over 10 minutes followed by 4400 units/kg/hour × 12–24 hours or (3) t-PA-100 mg given in a drip over 2 hours as an infusion (preferred agent)

Monitor thrombolytic therapy with estimation of

- Partial thromboplastin time (PTT)
- Thrombin time

If PTT remains less than twice the baseline value, institute heparin therapy

- Emergency embolectomy can be done before the clot fragments or gets organized
- Anticoagulation – Useful in mild cases but is of doubtful value in severe cases
- Other measures
  - ❑ O_2 therapy
  - ❑ Digitalis for right ventricular failure
  - ❑ Isoprenaline to increase cardiac output and maintain heart rate
  - ❑ Antibiotics in the presence of pulmonary infarction
  - ❑ Intravenous saline + dopamine or noradrenaline to maintain adequate BP
- Prevention of recurrent PE – Inferior venacava filter or clipping if anticoagulation fails, or as a temporary measure till anticoagulation becomes effective

Measures to prevent DVT

- Avoid prolonged immobilization
- Frequent change of posture
- Active and passive movements of lower limbs
- Avoid dehydration
- Use DVT stockings for prolonged immobilization
- Prophylactic low-molecular weight heparin
- Calf and respiratory exercises

Variceal bleeding

Varices are a manifestation of portal hypertension. The only clinical manifestation of varices is bleeding which can be massive. (Figs. 2.23–2.25)

1. **Clinical features** – Patient presents with hematemesis (differences between hematemesis and hemoptysis are discussed in Chapter 4). The other manifestations are coffee ground aspirate from nasogastric tube, melena or hematochezia. With massive bleeding, patients may present with hemodynamic instability. In patients with hepatocellular failure, hematemesis may precipitate hepatic encephalopathy. Severity of bleeding can be judged as follows:
   - Orthostatic hypotension (decrease in BP greater than 10 mm Hg and rise in pulse rate greater than 15 beats/minute) suggests 10–20% loss of circulatory blood volume.
   - Supine hypotension suggests greater than 20% blood loss.
   - Basal BP less than 100 mm Hg and tachycardia are indications for urgent fluid replacement.
2. **Diagnosis** of variceal bleeding is confirmed by upper GI endoscopy that can be performed as an emergency procedure. Additionally CBC, coagulation studies (PT, PTT, platelet count), grouping and cross matching of blood, LFT, and serum creatinine estimation are carried out.
3. **Management**
   - Urgent restoration of intravascular volume with saline, Ringer lactate or 5% dextrose, infused rapidly using a wide bore (14–18 gauge) catheter or central venous line. Packed RBC transfusions are necessary to achieve a hematocrit of greater than 25% (greater than 30% in patients with cardiac or pulmonary disease).
   - Patients with coagulation abnormalities are given 1–2 units of fresh frozen plasma along with intramuscular or IV 5–10 mg vitamin K. Simultaneously octreotide 50 μg is administered by IV bolus followed by infusion of 50 μg/hour. It increases splanchnic vascular resistance.
   - Vasopressors are not used or only transiently till volume loss is restored.
   - Endotracheal intubation to protect airway.
   - Urgent upper GI endoscopy is performed after fluid replacement and hemodynamic stability to identify the site and cause of bleeding and for therapeutic purposes in patients with severe blood loss and hemodynamic instability. In stable patients with small blood loss therapeutic procedure is usually deferred and performed as an

elective procedure. Metoclopramide 10 mg IV or erythromycin 150–250 mg hastens gastric emptying and allows clearer endoscopic view. The usual therapeutic procedure is variceal ligation or banding. It not only controls bleeding and eradicates varices but also reduces the rate of recurrence of bleeding. It is preferred to sclerotherapy.
- Transjugular intrahepatic portosystemic shunt is indicated with refractory variceal bleeding and gastric variceal bleeding. Main complication is hepatic encephalopathy.
- Indications for shunt surgery are failure of above measures, high risk of recurrence of bleeding, to treat recurrences or when medical care is not easily accessible.
- **Sengstaken Blackmore tube** used previously to mechanically compress the varices to stop bleeding is not advocated. Its disadvantage is risk of complications such as esophageal perforation and aspiration. Further it s uncomfortable to the patient and may require endotracheal intubation and IV sedation.

Acute diarrhea

1. **Introduction**
   Diarrhea is sudden onset of frequency or fluidity of stools. Common causes are infection, toxins and drugs; pseudomembranous colitis (PMC) is an important cause in patients on antibiotics.
   Impacted stools may manifest with pseudodiarrhea.
2. **Investigations** – Stool examination for blood, ova, parasites and stool culture. Clostridium difficile toxin assay and culture are carried out if PMC is suspected.
3. **Treatment**
   Hydration is carried out orally for mild to moderate cases and with IV fluids for severe diarrhea (Chapter 14, Viva voce, Q11).
   a. Symptomatic treatment
      Antidiarrheal
      - Loperamide 2–4 mg, maximum four times a day
      - Diphenoxylate and atropine, maximum 15–20 mg/day in divided doses
      - Pectin and kaolin to bind toxins
      - Codeine phosphate 15–30 mg BD or TDS
      - Psyllium or methylcellulose in small dose to decrease fluidity of stools
      - Bismuth subsalicylate (antibacterial)
      - Cholestyramine 1 g QID for bile acid-induced diarrhea
      - Octreotide (100–200 µg BD) for hormone-induced diarrhea
      - Antidiarrheals should not be used with bloody diarrhea of unknown cause (may exacerbate C. difficile colitis or increase the likelihood of hemolytic uremic syndrome in Shiga toxin producing Escherichia coli infection)
      - Antibiotics – Antibiotics are indicated for moderate to severe diarrhea.
      - Empirical antibiotic treatment
        - ❑ Ciprofloxacin 500 mg BD × 3 days
        - ❑ Norfloxacin 400 mg BD × 3 days
        - ❑ Trimethoprim – Sulfamethoxazole (160 mg/1800 mg) BD × 5 days
      - Specific antibiotic treatment
        - ❑ Metronidazole for amebic dysentery – 750 mg oral tds × 5–10 days or 500 mg (IV) 8 hourly × 5–10 days followed by iodoquinol 650 mg oral tds × 20 days
        - ❑ Metronidazole for giardiasis (oral) 250 mg tds × 5–7 days or tinidazole 2 g single dose (oral)
        - ❑ Furazolidone 100 mg BD × 10 days for giardiasis

In patients with AIDS, diarrhea can be due to usual organisms, opportunistic infections, lymphoma, Kaposi's sarcoma and HIV per se. Treatment depends upon the cause.

Fulminant hepatic failure

1. **Definition**
   Fulminant hepatic failure is defined as altered mental state along with coagulopathy (PT 5–6 seconds more than normal, INR greater than 1.5) occurring within 8–24 weeks of the onset of liver disease in an otherwise healthy individual.
2. **Causes**
   - Viral hepatitis (HCV, HBV, HDV)
   - Drugs – Isoniazid, paracetamol
   - Autoimmune hepatitis (AIH)
   - Toxins
   - Ischemia
   - Pregnancy (fatty liver of pregnancy)
   - Reye's syndrome
3. **Clinical features**
   - Mental changes, drowsiness progressing to coma. Neurological assessment should

include pupillary size and reaction to light. Extensor plantar response may by present
- Jaundice (may not be present)
- Cardiovascular collapse, renal failure, cerebral edema
- Sepsis may develop

Grading of hepatic encephalopathy

Grade I – Confusion, disorientation, altered sleep rhythm, anxiety

Grade II – Flaps, patient arousable

Grade III – Stupor, hypotonia, brisk tendon reflexes

Grade IV – Coma, decerebrate posturing

4. **Investigations**
   - Liver enzymes, SGOT and SGPT are sometimes greater than 1000 IU/L with SGPT > SGOT blood sugar, electrolytes, ABG, coagulation parameters
   - Serum ammonia
   - Viral markers
   - Toxin screen including drugs
   - Ceruloplasmin (in children and young adults)
   - Antinuclear antibody, AIH antibodies
   - Pregnancy test (for acute fatty liver of pregnancy)
5. **Management**

   Treat in ICU with
   - Serial estimations of blood sugar, coagulation profile, electrolytes, blood gases and fluid balance
   - Regular assessment of mental status and neurodeficit
   - Correction of intravascular volume depletion by IV colloids and crystalloid infusions
   - Inotropic support if hypotension persists despite good filling pressure

   Dialysis. Indications are –
   - Metabolic acidosis
   - Hyperkalemia
   - Fluid overload
   - Serum ammonia greater than 150 µmol/l
   - Rising serum creatinine
   - Cerebral edema not responding to mannitol

   Treatment of cerebral edema
     - ❑ For correct estimation of ICP, pressure monitoring devices are used, but their utility is not universally accepted. Also, the procedure carries the risk of infection and bleeding. Therapeutic measures are
     - ❑ Intravenous mannitol 0.5–1 g/kg. Danger is of developing hyperosmolality and volume load if used frequently
     - ❑ Hyperventilation – causes vasoconstriction with reduced cerebral blood flow
     - ❑ Other useful modalities are hypertonic saline.
   - Lactulose is useful in early stages of hepatic encephalopathy
   - Antibiotics are often used prophylactically
   - Nutrition requirement of these patients is high (35–50 kcal/kg). Protein intake should be 1 gm/kg to maintain nitrogen balance.
   - Correction of electrolyte disturbances
   - Treatment of coagulopathy
     - ❑ Plasma, with active bleeding only and not prophylactically
     - ❑ Platelet transfusion before a surgical procedure if platelet count is less than 50,000/mm^3
     - ❑ Vitamin K, activated factor VII may be used along with fresh frozen plasma
   - Sucralfate to prevent stress ulcer
   - If above measures fail, liver transplantation

Coma

1. **Common causes of coma**
   - Poisoning/drug overdose
   - Hypoglycemia, hyponatremia
   - Anoxia, CO2 narcosis
   - Hepatic failure
   - Renal failure
   - Stroke, hypertensive encephalopathy
   - Sepsis
   - Central nervous system infections
   - Intracranial space occupying lesion
2. **Principles of management of a comatose patient**
   - Ensure adequate airway, breathing and circulation
   - Prevent aspiration; nurse in lateral position
   - Collect blood for chemistry, toxin screen, infection
   - Administer thiamine hydrochloride along with IV glucose
   - Detailed history and physical examination; especially note injury, abnormal smell, high BP, neck stiffness and brain-stem functions
   - Prevent aspiration; nurse in lateral position
   - Ensure proper nutrition, preferably with enteral feeding

- Skin care
- Bladder, bowel care
- Establish an IV line
- General care of an unconscious patient
- Maintain clear airway
- Definitive treatment as per diagnosis

Status epilepticus

1. **Definition** – Tonic–clonic seizure activity lasting for more than 5–10 minutes or two or more seizures with nonrecovery of consciousness defines status epilepticus.

Uncontrolled seizures lasting for more than 60 minutes can result in permanent brain damage. Still longer seizure activity can prove fatal.

2. **Treatment**
   a. **General measures**
      - Treat in an ICU
      - Monitor vitals, BP and ECG
      - Establish two IV lines, one of which should be used exclusively for antiseizure medications (see below)
      - Ensure free airway to prevent airway compromise, if necessary intubate
      - Administer O_2
      - Collect blood for CBC, sugar, urea, creatinine, toxin screen
      - Inject thiamine hydrochloride 100 mg IV along with 50 ml of 50% glucose
      - Protect the patient from injury

   b. **Measures to control seizure activity**
      - Lorazepam 0.05–0.1 mg/kg IV at the rate of 2 mg/minute up to a maximum of 8 mg or diazepam 0.2 mg/kg at the rate of 5 mg/minute up to a maximum of 20 mg.
      - If seizures continue fosphenytoin 10–20 PE (phenytoin equivalent)/kg at the rate of 100–150 PE/minute or phenytoin 10–20 mg/kg IV in saline at the rate of 50 mg/minute. (Precaution – dextrose should not be used as phenytoin precipitates in dextrose solution.) If necessary, half of the first dose can be repeated. Patient should be monitored carefully with continuous BP ECG and recordings to detect hypotension and heart block.
      - Nonresponse to above measures defines refractory status epilepticus and is an indication for third antiepileptic and intubation if not already intubated. The additional antiepileptic can cause respiratory depression that necessitates mechanical ventilation. The antiepileptic can (1) phenobarbitone IV 15–20 mgm/kg, given at the rate of 100 mgm/min. The dose for children is 3 mgm/kg. If seizures continue still, further dose (5–10 mg/kg) of phenobarbitone can be given. Continuous ECG and BP monitoring are essential or (2) Intravenous valproic acid in a loading dose of 10–15 mg/kg can be given.
      - If convulsions still continue, administer (1) midazolam 0.2 mg/kg loading dose followed by 0.75–100 µg/kg maintenance dose as an IV infusion or (2) propofol 2 mg/kg loading dose followed by 30–250 mcg/kg/minute infusion, given until electroencephalogram shows suppression of seizure activity.
      - If seizures are still not controlled, general anesthesia with neuromuscular blockade is indicated.

   c. Identify and treat the precipitating cause

Raised intracranial pressure

Treatment consists of

- Twenty percent IV mannitol 0.5–1.0 g/kg administered over 15–20 minutes and repeated in the dose of 0.25–0.5 g/kg every 6–8 hours. Action of mannitol lasts for approximately 2 hours. Mannitol is used with caution in patients with ischemic heart disease (IHD), renal insufficiency and pulmonary vascular congestion, as it initially rapidly expands intravascular fluid volume. Prolonged use of mannitol can result in water loss with hypernatremia
- Furosemide 1 mg/kg, intravenously decreases body water and is useful to avoid transient mannitol-induced hypervolemia.

Treatment of intractable raised ICP

- Hyperventilation to lower $PaCO_2$ to 30–35 mm Hg
- Decompressive craniotomy
- Systemic hypothermia (not found to be helpful)
- Corticosteroids are not recommended as their use is associated with worse outcome

Cerebral malaria

Cerebral malaria is a serious complication of falciparum infection and carries a mortality rate of 20–30%.

1. **Clinical features**
    - Fever; hyperpyrexia are common.
    - Absence of neck stiffness (differentiates from meningitis).
    - Icterus may be present.
    - Pallor and splenomegaly are commonly present.
    - Central nervous system manifestations
    - Altered mental state (irritability, drowsiness, coma), convulsions, unequal pupils, extensor plantars, bladder incontinence
2. **Investigations**
    - Peripheral blood smear for *Plasmodium falciparum*.
    - Cerebrospinal fluid – (shows no abnormalities).
    - Other investigations as indicated. Hypoglycemia is common.
3. **Treatment**
    - **a.** In areas of high prevalence of resistant falciparum infection, artemisinin compounds are preferred for treatment. Artesunate is given in the dose of 2 mg/kg, followed by 1 mg/kg after 6 hours (with heavy parasitemia) and, subsequently daily for 4 days.

      Artemether is given as 160 mg (4 mg/kg intramuscular) on day 1 followed by 80 mg (2 mg/kg) intramuscular from day 2 to day 5
    - **b.** Quinine – 10 mg/kg given intravenously, slowly over 4–8 hours thrice daily is the treatment of choice except in areas with quinine resistant malaria. Intravenous route is replaced by oral administration as soon as possible (usually after 24 hours).

      Precautions
        - With renal failure, maintenance dose of quinine is reduced.
        - Electrocardiogram monitoring is necessary. Prolongation of QT interval (more than 0.6 seconds or increases by >25% of the baseline) is an indication to discontinue quinine.
        - Blood glucose should be monitored for hypoglycemia.
    - **c.** Exchange transfusion with high parasitemia (greater than 10%)
    - **d.** Other measures include
        - Maintenance of fluid balance
        - Mannitol for cerebral edema
        - Whole blood transfusions
        - Treatment of organ failure (e.g. renal, pulmonary edema)

Ischemic stroke

Clinical features are described in Chapter 5 (Neurology)

1. **Management**
    - Hospitalize the patient
    - Stabilize the patient. This may include airway support, oxygenation, ventilatory support
    - Monitor and treat ICP if raised
    - Treat fever, hyperglycemia, dehydration
    - Treat hypertension with labetalol or nicardipine if systolic BP is greater than 200 mm Hg, or diastolic BP is greater than 120 mm Hg, recorded twice at more than 15-minute interval. BP is reduced by 10–15%
    - Antithrombotic treatment with recombinant tPA if the patient is seen within 3 hours of the onset of stroke and if there are no contraindications, such as
        - ❑ Intracranial bleed (detected by CT) and subarachnoid hemorrhage (SAH)
        - ❑ Multilobar infarct
        - ❑ Systolic BP greater than 185 mm Hg or diastolic BP greater than 100 mm Hg after antihypertensive treatment
        - ❑ History of recent stroke (within previous 3 months)
        - ❑ Rapidly improving patient
        - ❑ Low platelet count; patient on anticoagulants
        - ❑ H/o convulsions at the onset of stroke
        - ❑ Very high (greater than 400 mg/dl) or very low (less than 50 mg/dl) blood glucose
        - ❑ Suspected endocarditis
        - ❑ Pregnancy
        - ❑ Recent surgery, recent lumbar puncture
    - Thrombolysis in situ can be carried out with occlusion of middle cerebral artery if the patient is seen between 3 and 6 hours of the onset of symptoms.

- Anticoagulation (with heparin, warfarin) for stroke due to
  - Cerebral venous thrombosis
  - Embolic stroke secondary to AF
  - Progressive stroke (hemorrhage should be excluded)
- Supportive care. Physiotherapy
- Treatment of associated conditions such as acute myocardial infarction, aortic dissection, pulmonary edema, ARF and retinal hemorrhages
  - Long-term treatment
- Carotid endarterectomy. Indications are
  - Recent, nondisabling stroke due to significant (70–99%) occlusion of ipsilateral carotid artery
  - For patients with symptoms, more than 60%, ipsilateral carotid occlusion
  - Expected life expectancy, at least 5 years
- For secondary prevention, oral antiplatelet drugs – Aspirin (81–325 mg/day) alone or in combination with other antiplatelet drugs or warfarin.

Intracerebral hemorrhage

Clinical features are described in Chapter 5 (Neurology)

The management consists of

- Supportive measures
- Treatment of associated risk factors
- Control of BP, if systolic BP is greater than 185 mm Hg or mean arterial pressure is greater than 130 mm Hg.
- Surgical evacuation of cerebellar hematoma is indicated if it is greater than 3 cm in diameter and causing herniation.
- Early evacuation of deep seated cerebral hematoma carries high mortality and is seldom advocated.

Subarachnoid hemorrhage

- Hospitalize the patient, ideally in a specialized center
- Management
  - Control BP, if the mean arterial pressure is greater than 130 mm Hg
  - Absolute bed rest
  - Symptomatic treatment of headache, restlessness
  - Stool softeners (to avoid straining)
  - Nimodipine 60 mg orally, every 4 hours for 21 days (to prevent vasospasm); blood pressure to be maintained in the effective range
  - Ventricular drainage for acute hydrocephalus
  - Surgical clipping or coil occlusion of aneurysm; if patient is arousable, then performed within the first 24 hours to reduce the risk of rebleeding; if SAH is of more than 24-hour duration, surgery is deferred for 10 days or so.

Thyroid storm

1. **Definition** – Thyroid storm is severe hyperthyroidism (tachycardia, palpitations, fever and other features of thyrotoxicosis) along with delirium.
2. **Diagnosis** is confirmed by estimating thyroid-stimulating hormone and free T4 levels. Blood for the estimation of hormone levels should be collected before initiating therapy.
3. **Treatment**
   - Propylthiouracil (PTU) 600 mg PO, followed by 300–400 mg QID is started immediately
   - Lugol's iodine 10 drops, every 8–12 hours, is started 1 hour after the first dose of PTU
   - Propranolol 40 mg, every 6 hours, PO is given to patients with symptomatic IHD to control the heart rate. In the presence of heart failure propranolol can worsen heart failure, hence is to be given with caution
   - Intravenous dextrose
   - Correction of fluid and electrolyte imbalance
   - Ca-channel blockers, β-blockers or adenosine for AF
   - Hydrocortisone 100 mg IV every 8 hours or dexamethasone 8 mg IV
   - Cooling measures to lower temperature
   - Treatment of precipitating cause, e.g. infection
4. **Monitoring**

   T4 should be estimated every 4–6 days till T4 level is normalized. At this point, the doses of PTU and Lugol's iodine are decreased.

   Patient can be subjected to radioiodine therapy 15 days after iodine is discontinued. Rarely the patient may require thyroidectomy.

Adrenal crisis

Hypotension, hyponatremia, hyperkalemia, nausea, asthenia, severe abdominal pain, low back, or leg pain are the features of adrenal failure. If untreated, renal failure develops.

1. **Treatment**
   It should be started as soon as the condition is suspected.
   a. Treatment of a known patient of Addison's disease
      i. Hydrocortisone 100 mg IV, every 8 hours, along with rapid infusion of 5% dextrose–saline till dehydration and hypotension are corrected
      ii. Hydrocortisone is tapered slowly until the underlying cause and symptoms are resolved,
      iii. Treatment of the precipitating cause which is often an infection

On recovery, oral maintenance therapy with prednisolone is continued. In patients with primary adrenal failure, fludrocortisone 0.05–0.2 mg/day along with liberal salt intake is advised. With proper replacement therapy, normal BP and serum K levels should be maintained. Patient should be provided with an identification card, bracelet or a tag.

   b. Treatment in a suspected case of adrenal crisis (not known to be a patient of Addison's disease)
      i. Dexamethasone 5 mg IV
      ii. Rapid infusion of 5% dextrose – saline
      iii. Perform cortisone stimulation test and then start hydrocortisone 100 mg every 8 hours until the test result is obtained and modify or continue treatment accordingly

Febrile neutropenia

1. **Definition** – Neutropenia is defined as absolute neutrophil count (ANC) less than 500/mm.

   Fever is defined as a single recorded core temperature greater than 38.3 °C or two readings greater than 38 °C, spanning 1 hour. In patients with febrile neutropenia, infection must be assumed, evaluated for, and treated.
2. **Investigations** – Two sets of cultures from blood, urine, stool, sputum, and from any other suspected focus should be obtained.
3. **Treatment**
   a. Patients should be nursed in reverse isolation observing all sterile precautions.
   b. All likely offending drugs should be discontinued.
   c. Antibiotic treatment should be initiated immediately after cultures are collected. Initial treatment is empirical and should cover Gram negative organisms including pseudomonas and Gram positive organisms including α-hemolytic streptococcus (e.g. aminoglycoside + semisynthetic penicillin). Antibiotics are continued until ANC is greater than 500/mm^3. Vancomycin is added if there is evidence of methicillin resistant staphylococcus aureus (MRSA); antibiotics are changed based on culture report. Empiric amphotericin B (0.5 mg/kg increased to 1.0 mg/kg) is added if the fever does not respond within 72 hours.
   d. Granulocyte colony stimulating factor and granulocyte macrophage colony stimulating factor (GMCSF). Granulocyte colony stimulating factor or GMCSF should be given within 24 hours of chemotherapy or radiation. It may reduce the occurrence of febrile neutropenia. It may also benefit patients with idiosyncratic drug reaction causing neutropenia.
   e. Other measures
      - Saline or hydrogen peroxide gargles every few hours
      - Anesthetic lozenges (3–4 hourly); 1% chlorhexidine mouth washes, every 3–4 hours to relieve discomfort caused by oral ulceration
      - Nystatin 4–6 lac units oral rinses, every 6 hours for oral candidiasis. It is swallowed if esophagus is involved. Alternatively fluconazole 50 mg, daily for 7–14 days is administered

Causes of persistent fever despite antibiotic therapy in a patient of febrile neutropenia

- Nonbacterial cause
- Resistant organisms
- Superinfection with another organism
- Inadequate drug levels
- Localized infection, e.g. abscess

Mismatch blood transfusion

Mismatch blood transfusion reaction is a serious complication of blood transfusion. It is most commonly due to ABO incompatibility though antibodies against other antigens can also cause acute hemolytic reaction. There is intravascular hemolysis which leads to ARF and DIC. The degree of mismatch, the amount of blood transfused, the rate of transfusion, and renal, hepatic and cardiac status determine the severity of the reaction.

1. **Clinical features**
   - Onset is abrupt, usually within 1 hour of start of transfusion
   - Symptoms – Discomfort, anxiety, chills, fever, flushing, severe loin pain, shock, dark urine (cola color) and jaundice (develops later)
2. **Diagnosis is confirmed by**
   - Hemoglobinuria
   - Elevated serum lactic dehydrogenase
   - Low haptoglobin
   - Increased serum bilirubin (late manifestation)
3. **Management**
   - Stop transfusion.
   - Collect clotted blood and EDTA blood samples and send them to the blood bank. Also send the remaining blood for rechecking the crossmatches.
   - Administer IV 0.9% saline to maintain intravascular blood volume and urine output of greater than or equal to 100 ml/hour. Diuretic (furosemide 40–80 mg stat with subsequent dose adjusted to maintain the desired urine output) and mannitol are used if the urine output is not satisfactory.
   - Alkalanise urine (pH greater than or equal to 8.0) with IV sodium bicarbonate.
   - Early dialysis is performed.

Appendix A

LABORATORY REFERENCE VALUES

Serum biochemistry

Acid phosphatase (ACP) (total)	0.5–4 KAU/dl
Adenosine deaminase (ADA)	Normal <30 U/l Suspect >40–60 U/l Positive >60 U/l
Adrenocorticotropic hormone (ACTH)	
9 hours	10–50 pg/ml
24 hours	<10 pg/ml
Alanine aminotransferase (ALT/SGPT)	
Male	13–35 IU/l
Female	10–30 IU/l
Albumin	3.5–5 g/dl
Aldolase	1.5–7 IU/l
Aldosterone (lying)	4.9–14.4 ng/dl
Alkaline phosphatase (ALP)	3–13 KAU/dl
Alkaline phosphatase (heat stable) (liver origin)	18–44% of total activity
Alpha-fetoprotein	5–15 ng/ml
Alpha-1-antitrypsin	110–410 mg/dl
Ammonia	9–33 umol/l
Amylase	25–125 IU/l
Angiotensin-converting enzyme (ACE)	10–70 IU/l
Antidiuretic hormone (ADH) (arginine vasopressin)	1–13 pg/ml
Aspartate aminotransferase (AST)	12–39 IU/l
Bicarbonate (HCO_3)	22–26 mEq/l
Bilirubin	
Total	0.2–1 mg/dl
Direct	0.1–0.8 mg/dl
Indirect	0.8 mg/dl
Blood gas (arterial)	
pH	7.35–7.45
PO_2	90–105 mm Hg
PCO_2	35–45 mm Hg
Brain natriuretic peptide (BNP)	Normal up to 80 pg/ml Borderline 81–100 pg/ml High > 100 pg/ml
Calcium	
Total	9–11 mg/dl
Ionized	4.5–5.5 mg/dl
Calcitonin	0–20 pg/ml
Carcinoembryonic antigen (CEA)	<5 ng/ml
Catecholamines	
Noradrenaline	<600 pg/ml
Adrenaline	<100 pg/ml

Ceruloplasmin	25–50 mg/dl
Chloride	96–106 mEq/l
Cholesterol (total)	150–200 mg/dl
HDL fraction	
Male	30–60 mg/dl
Female	35–75 mg/dl
LDL fraction	60–140 mg/dl
Triglycerides	30–150 mg/dl
Lipoprotein (a)	Up to 30 mg/dl
Apo A1	96–176 mg/dl
Apo B	43–128 mg/dl
Ratio Apo B/Apo A1	<1.0
Complement	
C3	80–120 mg/dl
C4	25–40 mg/dl
Copper	70–150 ug/dl
Cortisol	
At 9 A.M.	5–25 ug/dl
Midnight	2.5 ug/dl
C-reactive protein (CRP)	0.5–1 mg/dl
Creatine phosphokinase (CPK) (total)	
Male	30–200 IU/l
Female	30–150 IU/l
MB fraction	0–20 IU/l
Creatinine	0.7–1.2 mg/dl
Creatinine clearance	80–109 ml/min
Cyanocobalamin (vitamin B12)	20–80 ng/dl
Dehydroepiandrosterone (DHEAS)	
Male	1031–4422 ng/ml
Female	700–3464 ng/dl
Dihydrotestosterone (DHT)	
Male	1–2.6 nmol/l
Female	0.3–0.93 nmol/l
Ferritin	
Male	20–260 ng/ml
Female	6–110 ng/ml
Folic acid	5–20 ng/dl

Follicle-stimulating hormone	
Male	1–10 mIU/ml
Follicular	1–10 mIU/ml
Midcycle	<50 mIU/ml
Luteal	1–8 mIU/ml
Postmenopausal	>25 mIU/ml
Fructosamine	205–285 umol/l
Gamma-glutamyl transpeptidase (GGT)	
Male	5–75 IU/l
Female	5–45 IU/l
Serum glutamic pyruvic transaminase (SGPT)	5–40 IU/l
Serum glutamic oxaloacetic transaminase (SGOT)	5–40 IU/l
Gastrin (fasting)	<180 pg/ml
Globulins	2.5–3.5 g/dl
Glucagon	2–10 ng/dl
Glycated hemoglobin (HbAlc) (target)	4–7%
Growth hormone (GH)	2–6 ng/l
Haptoglobulin	40–175 mg/dl
Homocysteine	5–20 umol/l
Human chorionic gonadotropin (HCG)	<3 mIU/ml
17-Hydroxyprogresterone	
Follicular	0.3–3.3 ug/l
Luteal	0.3–6.6 ug/l
Immunoglobulin	
IgA	80–400 mg/dl
IgG	550–1650 mg/dl
IgM	40–200 mg/dl
IgE	<11 IU/ml
Insulin (fasting)	<20 uU/ml
Iodine	5–10 ug/dl
Iron	
Male	60–180 ug/dl
Female	40–170 ug/dl
Serum lactate	0.5–1.3 mEq/l

Lactate dehydrogenase (LDH)	25–200 IU/l
Lipase	23–300 IU/l
Lipids (total)	400–600 mg/dl
Serum lithium (therapeutic level)	0.6–1.2 mmol/l
Serum lithium (toxic level)	1.5–2.1 mmol/l and above
Luteinizing hormone	
Male	1.0–8.0 mIU/ml
Follicular	1.0–10.0 mIU/ml
Midcycle	<75 mIU/ml
Postmenopausal	>16 mIU/ml
Magnesium	1.8–2.2 mg/dl
Estradiol	
Male	<45 pg/ml
Follicular	50–110 pg/ml
Midcycle	110–330 pg/ml
Luteal	110–272 pg/ml
Postmenopausal	<30 pg/ml
Prepubertal	<10 pg/ml
Serum osmolality	275–295 mOsmol/kg
Parathyroid hormone (PTH) (adult)	1.1–6.8 pmol/l
Potassium	3.5–5.5 mEq/l
Progesterone	
Follicular	<2.5 ng/ml
Luteal	>10 ng/ml
Prolactin	<400 mU/l
Prostate-specific antigen (PSA) (male)	<4.0 ug/l
Protein total	6–8 g/dl
Prothrombin	10–15 mg/dl
Pseudocholinesterase	8–18 ID/ml
Renin	
Lying	230–1000 pmol/l/hour
Standing	460–1550 pmol/l/hour
Selenium	50–100 ng/dl
Serotonin	4–36 mg/dl

Sodium	136–146 mEq/l
Blood sugar	
Fasting	65–110 mg/dl
Postlunch/postglucose	<140 mg/dl
Random	<160 mg/dl
After 30 minutes	<200 mg/dl
After 1 hour	<200 mg/dl
After 1½ hours	<200 mg/dl
After 2 hours	<140 mg/dl
After 3 hours	<140 mg/dl
Testosterone	
Male	2.6–11.8 ng/ml
Female	<0.8 ng/ml
Thyroglobulin (Tg)	3–5 ng/dl
Thyroid-stimulating hormone	0.3–4.0 uU/ml
Thyroxine, free (fT4)	0.8–2.0 ng/dl
Thyroxine, total (tT4)	4.5–11.0 ug/dl
Tri-iodothyronine (T3)	78–145 ng/dl
Troponin I	0–0.4 ug/l
Troponin T	0–0.1 ug/l
Urea	20–40 mg/dl
Urea nitrogen	8–20 mg/dl
Uric acid	
Male	3.5–7 mg/dl
Female	3.0–6 mg/dl
Vanillylmandelic acid (VMA) (urine)	2–6 mg/d
Vitamin A	15–50 ug/dl
Vitamin C (ascorbic acid)	0.4–1.5 mg/dl
Vitamin D (calcitriol)	1.5–6 ug/dl
Vitamin E	0.5–1.8 mg/dl
Zinc	72–157 ug/dl

CSF

Glucose	70% of serum mg/dl
Protein	<40 mg/dl

Urine (per 24 hours)

Albumin	<20 mg/24 hours

Catecholamines (adult)	
Noradrenaline	<95 ug/24 hours
Adrenaline	<26 ug/24 hours
24-hour urinary metanephrine	<1.0 mg/24 hours
Cortisol (free)	60–180 mmol/24 hours
Osmolality	50–1200 mOsm/kg
Porphobilinogen	No excess
Porphyrins	No excess
Protein (total)	<150 mg/24 hours
Urinary sodium	40–220 mmol/24 hours
Urinary potassium	25–125 mmol/24 hours
Urinary uric acid	250–750 mg/24 hours
Microalbuminuria (random)	Positive if >3.0 mg/dl
Microalbuminuria (24 hours)	30–165 mg/24 hours
Urinary copper	0–75 ug/24 hours
Xylose absorption (urine)	1.2–2.4 g/5 g
Vanillylmandelic acid (VMA) (urine)	1.9–9.8 mg/24 hours
17-Ketosteroids (urine)	
Male	10–25 mg/24 hours
Female	5–11 mg/24 hours
Urobilinogen	No excess

Feces (stools)

Occult blood	Nondetectable
Porphyrins	No excess
Total fat	<5 g/24 hours
Weight	<200 g/24 hours

Sweat

Sodium	<60 mEq/l
Chloride	<70 mEq/l

Hematology

FDP	<5 ugm%
Osmotic fragility	50–95%
White blood cells	4000–10,000/cmm
Neutrophils	40–75%
Eosinophils	0–6%
Lymphocytes	20–45%
Monocytes	1–10%
Basophils	0–1%
RBC	4.0–6.0 M/Ul
Hemoglobin	
Male	14–16.0 g/dl
Female	13–15 g/dl
PCV	
Male	40–54%
Female	35–47%
MCV	75.0–95.0
MCH	25.0–35.0
MCHC	30.0–35.0%
Platelet count	140,000–440,000/CMM
ESR	
Male	0–15 mm/hour
Female	0–20 mm/hour
Reticulocytes	0.2–2.0%
Bleeding time	3–10 minutes
Prothrombin time	Control – 13.0 seconds
Partial thromboplastin time	Control – 15.0 seconds
Fibrinogen (plasma)	200–400 mg%
Total iron-binding capacity	200–400 ugm%
Transferrin saturation	15–30%
Antithrombin III	80–120%
Protein C	70–130%
Protein S	65–140%
D-Dimer	<5 ng/ml

Appendix A

Pulmonary physiology – Useful values

Pulmonary mechanics	Symbol	Values	
		Male	Female
Spirometry			
Forced vital capacity	FVC	4.8 l	3.3 l
Forced expiratory volume in 1 second	FEV_1	≥3.8 l	≥2.8 l
FEV_1/FVC	FEV_1%	≥76%	≥77%
Maximum midexpiratory flow	MMF	≥4.8 l/s	≥3.6 l/s
Maximum expiratory flow rate	MEFR	≥9.4 l/s	≥6.1 l/s
Lung volumes			
Total lung capacity	TLC	6.4 l	4.9 l
Functional residual capacity	FRC	2.2 l	2.6 l
Inspiratory capacity	IC	4.8 l	3.7 l
Residual volume	RV	1.5 l	1.2 l
Vital capacity	VC	1.7 l	1.4 l

Blood gas analysis (on breathing ambient air)	Normal values
O_2 saturation	95–100%
Arterial oxygen tension (PaO_2)	80–100 mm Hg
Arterial CO_2 tension ($PaCO_2$)	35–45 mm Hg
pH	7.35–7.45
Plasma HCO_3	22–26 mEq/l

Hemodynamic values – Pressure (mm Hg)

Left ventricle	
Peak systolic/end-diastolic	100–140/3–12
Left atrium (or pulmonary capillary wedge)	
Mean	2–12
Systemic arterial	
Peak systolic/end-diastolic	100–140/60–90
Mean	70–105
Right ventricle	
Peak systolic/end-diastolic	15–30/2–7
Right atrium	
Mean	2–6
Pulmonary artery	
Peak systolic/end-diastolic	15–30/4–14
Mean	9–17
Cardiac output (l/minute/m^2)	700–1600
Stroke index (ml/beat/m^2)	30–64

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Appendix B

ABBREVIATIONS

A_2	Aortic component of the second heart sound
Ab	Antibody
AB	Apex beat
ABG	Arterial blood gas (PaO_2, $PaCO_2$, pH, HCO_3)
ACE(i)	Angiotensin-converting enzyme (inhibitors)
ACTH	Adrenocorticotropic hormone
ADH	Antidiuretic hormone
AF	Atrial fibrillation
AFB	Acid-fast bacillus
AFP or α-FP	Alpha-fetoprotein
Ag	Antigen
AI	Aortic incompetence
AIDS	Acquired immunodeficiency syndrome
Alk phos	Alkaline phosphatase
ALL	Acute lymphoblastic leukemia
AMA	Antimitochondrial antibody
AMI	Acute myocardial infarction
ANA	Antinuclear antibody
ANF	Antinuclear factor
ANCA	Antineutrophil cytoplasmic antibody
AP	Angina pectoris
AR	Aortic regurgitation
ARDS	Acute respiratory distress syndrome
ARF	Acute renal failure
ART	Artery
AS	Aortic stenosis
ASD	Atrial septal defect
ASO(T)	Antistreptolysin O (titer)
ATN	Acute tubular necrosis
ATP	Adenosine triphosphate
AV	Atrioventricular
AVM	Arteriovenous malformation
BMI	Body mass index
BP	Blood pressure
CABG	Coronary artery bypass graft
CAD	Coronary artery disease
CBD	Common bile duct
CCF	Congestive cardiac failure (i.e. left and right heart failure)
CCU	Coronary care unit
CHB	Complete heart block
CHD	Coronary heart disease (related to ischemia and atheroma)
CMI	Cell-mediated immunity
CLL/CML	Chronic lymphocytic leukemia/ chronic myeloid leukemia

CMV	Cytomegalovirus
CMP	Cardiomyopathy
CNS	Central nervous system
COPD	Chronic obstructive pulmonary disease
CPR	Cardiopulmonary resuscitation
CRF	Chronic renal failure
CRP	C-reactive protein
CSF	Cerebrospinal fluid
CCP	Chronic constrictive pericarditis
CT	Computed tomography
CVP	Central venous pressure
CVS	Cardiovascular system
CXR	Chest X-ray
d	Day
DIC	Disseminated intravascular coagulation
Diast	Diastolic
DIP	Distal interphalangeal
dl	Deciliter
DKA	Diabetic ketoacidosis
DM	Diabetes mellitus
DU	Duodenal ulcer
DVT	Deep venous thrombosis
EBV	Epstein-Barr virus
ECG	Electrocardiogram
Echo	Echocardiogram
EEG	Electroencephalogram
ELISA	Enzyme-linked immunosorbent assay
EMG	Electromyogram
ENT	Ear, nose and throat
ERCP	Endoscopic retrograde cholangiopancreatography
ESR	Erythrocyte sedimentation rate
ESRF	End-stage renal failure
FDP	Fibrin degradation products
FEV_1	Forced expiratory volume in 1 second
F_1O_2	Partial pressure of O_2 in inspired air
FFP	Fresh frozen plasma
FPG	Fasting plasma glucose
FVC	Forced vital capacity
g	Gram
GB	Gall bladder
GE	General examination
GCS	Glucocorticosteroid
GFR	Glomerular filtration rate
GGT	Gamma-glutamyl transpeptidase
GH	Growth hormone
GIS	Gastrointestinal system
G_6PD	Glucose-6-phosphate dehydrogenase
GTN	Glyceryl trinitrate
GTT	Glucose tolerance test (also OGTT – oral GTT)
H	Hypogastric region
HAV	Hepatitis A virus
Hb	Hemoglobin
HBs Ag/HBV	Hepatitis B surface antigen/hepatitis B virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C virus
HDV	Hepatitis D virus
HDL	high-density lipoprotein
HSP	Henoch–Schonlein purpura
HIV	Human immunodeficiency virus
HOCM	Hypertrophic obstructive cardiomyopathy
HRT	Hormone replacement therapy
IBD	Inflammatory bowel disease
IBS	Irritable bowel syndrome
ICP	Intracranial pressure
IDA	Iron deficiency anemia
ICS	Intercostal space
IDDM	Insulin-dependent diabetes mellitus
IFG	Impaired fasting glucose
IE	Infective endocarditis
IGT	Impaired glucose tolerance
Ig	Immunoglobulin

IHD	Ischemic heart disease
IHSS	Idiopathic hypertrophic subvalvular stenosis
IM	Intramuscular
INR	International normalized ratio (prothrombin ratio)
IP	Interphalangeal
IPPV	Intermittent positive pressure ventilation
ITP	Idiopathic thrombocytopenic purpura
IVC	Inferior vena cava
JVP	Jugular venous pressure
K	Potassium
Kg	Kilogram
L	Liter
LA	Left atrium
LAD	Left axis deviation on the ECG; also left anterior descending (coronary artery)
LAH	Left atrial hypertrophy
LBBB	Left bundle branch block
LDL	Low-density lipoprotein
LFT	Liver function test
LH	Luteinizing hormone
LHC	Left hypochondriac
LIF	Left iliac fossa
LMN	Lower motor neuron
LLR	Left lumbar region
LP	Lumbar puncture
Lt	Left
LUQ	Left upper quadrant
LVF	Left ventricular failure
LVH	Left ventricular hypertrophy
μg	Microgram
MCP	Metacarpophalangeal
MCV	Mean corpuscular volume
mg	Milligram
MI	Mitral incompetence
min(s)	Minute(s)
ml	Milliliter
mmHg	Millimeters of mercury
MND	Motor neuron disease
MRCP	Magnetic resonance cholangiopancreatography
MRI	Magnetic resonance imaging
MS	Mitral stenosis
MVP	Mitral valve prolapse
NAD	Nothing abnormal detected
NBM	Nil by mouth
ng	Nanogram
NG(T)	Nasogastric (tube)
NIDDM	Noninsulin-dependent diabetes mellitus
NR	Normal range (same as reference interval)
NSAIDs	Nonsteroidal anti-inflammatory drugs
od	Omni die (once daily)
EGD	Esophagogastroduodenoscopy
OGTT	Oral glucose tolerance test
OPD	Outpatients department
P_2	Pulmonary component of second heart sound
$PaCO_2$	Partial pressure of carbon dioxide in arterial blood
PAN	Polyarteritis nodosa
PaO_2	Partial pressure of oxygen in arterial blood
PBC	Primary biliary cirrhosis
PCR	Polymerase chain reaction
PCV	Packed cell volume
PDA	Patent ductus arteriosus
PE	Pulmonary embolism
PEEP	Positive end-expiratory pressure
PEF(R)	Peak expiratory flow (rate)
PFT	Pulmonary function test
PHT	Pulmonary hypertension
PIP	Proximal interphalangeal (joint)
PID	Prolapsed intervertebral disc
PND	Paroxysmal nocturnal dyspnea

PO	*per os* (by mouth)
PPI	Proton pump inhibitor
PR	Per rectum (by the rectum)
PSA	Prostate-specific antigen
PTH	Parathyroid hormone
PTT	Prothrombin time
Pulm	Pulmonary
PUO	Pyrexia of unknown origin
qds	*quarter die sumendus* (to be taken 4 times daily)
Rt	Right
RA	Rheumatoid arthritis
RAD	Right axis deviation
RAH	Right atrial hypertrophy
RBBB	Right bundle branch block
RBC	Red blood cell
RHC	Right hypochondriac
RHD	Rheumatic heart disease
RL	Right lumbar region
RIF	Right iliac fossa
RUQ	Right upper quadrant
RV	Right ventricle
RVF	Right ventricular failure
RVH	Right ventricular hypertrophy
S or sec	Second(s)
S1, S2, S3, S4	First, second, third and fourth heart sound
SC	Subcutaneous
SIADH	Syndrome of inappropriate antidiuretic hormone
sd	Standard deviation
Stat	Statim (immediately; as initial dose)
STD/STI	Sexually-transmitted disease of sexually-transmitted infection
SVC	Superior vena cava
sy(n)	Syndrome
Syst	Systolic
T°	Temperature
T3	Triiodothyronine
T4	Thyroxine
TB	Tuberculosis
tds	*ter die sumendus* (to be taken three times a day)
TFTs	Thyroid function tests
TEE	Transesophageal echocardiography
TIA	Transient ischemic attack
TIBC	Total iron-binding capacity
tid	*ter in die* (three times a day)
TPR	Temperature, pulse and respiration
TRH	Thyroid-releasing hormone
TSH	Thyroid-stimulating hormone
U	Units
UC	Ulcerative colitis
UMN	Upper motor neuron
URT(I)	Upper respiratory tract (infection)
US(S)	Ultrasound (scan)
UTI	Urinary tract infection
VDRL	Venereal diseases research laboratory
VE	Ventricular extrasystole
VMA	Vanillylmandelic acid (HMMA)
V Q	Ventilation/perfusion ratio
VSD	Ventricular septal defect
VT	Ventricular tachycardia
WBC	White blood cell
wk(s)	Week(s)
yr(s)	Year(s)
ZN	Ziehl–Neelsen

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